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The underground economy and the fiscal stance

- Is there a natural level of the underground economy and how does it affect fiscal consolidation? -

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The underground economy and the fiscal stance - Is there a natural level of the underground economy and how does it affect fiscal consolidation? -

Abstract

The inevitability of taxes and regulations, that cause agents to go underground, forces the authorities to tolerate some underground economic activity and grants the underground economy natural features. The natural level of the underground economy is defined as the level of underground economic activity in the decentralized equilibrium, provided that the actual structural characteristics of the economy and social preferences are accounted for by imbedding them in the Walrasian system of general equilibrium equations. Its existence is proven using two variants of neoclassical general equilibrium models.

The underground economy is found to influence the successfulness of fiscal consolidation programmes, depending on the position of the economy relative to critical fiscal thresholds associated with the natural level of the underground economy. Tax increases yield higher tax proceeds up to the threshold, and lower tax proceeds, passed the threshold, due to a stronger expansion of the natural level of the underground economy. Tax proceeds reach their maximum at the threshold.

Tax based programmes are found ineffective in high tax developed economies, operating passed the threshold. In contrast, its successfulness in the developing world, where most economies operate below the threshold with low taxes, is not influenced by the underground economy.

Keywords: underground economy, tax evasion, fiscal policy, stabilization, deficit, debt, (applied) general equilibrium models, two sector growth models, simulation modelling.

JEL Classification: E26, H26, E62, E63, H3, H30, H62, H63, C68, D58, O41, C63.

A economia subterrânea e a sustentabilidade das finanças publicas - Existe uma taxa natural de economia subterrânea e como influi nos resultados de programas de consolidação orçamental? -

Resumo

Perante a inevitabilidade de impostos e regulamentação, que estão na origem da economia subterrânea, as autoridades vêem-se forçadas a tolerar actividades económicas subterrâneas. Isto confere um carácter natural à economia subterrânea. A existência de uma taxa natural de economia subterrânea é provado utilizando dois modelos neoclássicos de equilíbrio gereal. A taxa natural de economia subterrânea define-se como o nível de actividade económica subterrânea no equilíbrio descentralizado, dadas as propriedades estruturais da economia e das preferências sociais, que se incluem no sistema Walrasiano de equações de equilíbrio geral.

Prova-se que a economia subterrânea influencia o resultado de programas de consolidação orçamental. Isto depende da localização da economia face a valores fiscais críticos associados à taxa natural de economia subterrânea. A seguir a um aumento de impostos, as receitas começam por crescer, atingindo o máximo no ponto crítico, para a seguir cair, devido a uma expansão da taxa natural de economia subterrânea.

Programas assentes no aumento de impostos não são bem sucedidos em países desenvolvidos com cargas fiscais elevadas, que operam além do ponto crítico. Já os países em desenvolvimento, cuja maioria opera abaixo do ponto crítico com cargas fiscais baixas, a economia subterrânea não parece influenciar a eficácia dos programas.

Palavras chave: Economia subterrânea, evasão de impostos, politica orçamental, consolidação orçamental, defice, divida, modelos de equilíbrio geral aplicados, modelos de crescimento economico de dois sectores, simulação.

Classificação JEL: E26, H26, E62, E63, H3, H30, H62, H63, C68, D58, O41, C63.

De parallelle economie en de overheidsfinanciën – bestaat er een natuurlijk niveau van de parallelle economie en hoe beïnvloedt dit de uitkomsten van programma's om de overheidsfinanciën te saneren? -

Samenvatting

Vanwege de onoverkomelijkheid van belastingen en regulering, die parallelle economische activiteiten induceren, zien de autoriteiten zich genoodzaakt deze activiteiten te tolereren. Dit verschaft een natuurlijk karakter aan de parallelle economie. De natuurlijke parallelle economie is het niveau aan parallelle economische activiteiten in het gedecentraliseerde marktevenwicht, gegeven dat de huidige structurele eigenschappen van de economie en van de sociale voorkeuren erbij worden betrokken door inbedding ervan in de algemene evenwichtsvergelijkingen in het systeem van Walras. Zijn bestaan wordt bewezen met behulp van twee neo-klassieke algemene evenwichtsmodellen.

Bewezen wordt dat de effectiviteit van saneringsprogramma's die stoelen op belastingverhogingen beïnvloed wordt door de parallelle economie, afhankelijk van de positie van de economie in relatie tot kritieke belastingdrempels, die samenhangen met de naturlijke parallelle economie. Dit is het belastingniveau tot waar belastingverhogingen leiden tot extra belastingopbrengsten en hun maximum bereiken, waarna die afnemen.

Saneringsprogramma's die stoelen op belastingverhogingen zijn niet succesvol in ontwikkelde landen met een hoge belastingdruk, die opereren voorbij het kritieke belastingniveau. Daarentegen schijnt de parallelle economie geen rol te spelen in ontwikkelingslanden, waar de belastingdruk - over het algemeen - lager is en de economieën onder het kritieke belastingniveau opereren.

Sleutelwoorden: Parallelle economie, belastingontduiking, duurzame overheidsfinanciën, sanering overheidsfinanciën, begrotingssaldo, overheidsschuld, toegepaste algemene evenwichtsmodellen, economische groeimodellen met twee sectoren, simulaties.

JEL Classificatie: E26, H26, E62, E63, H3, H30, H62, H63, C68, D58, O41, C63.

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Chapter 1. Introduction

Economic activities that are not contained in the official statistics make up the underground economy, apart from the underground economic activities included in the official statistics through imputation. Underground economic activities are deliberately concealed from the authorities in an attempt to evade taxes and social security contributions or in an attempt to prevent the detection of other infringements.

Empirical research[1] shows that the underground economy is a worldwide growing phenomenon and that it is not a phenomenon exclusive to less developed countries. It is sizeable in the developed world as well. But its size, causes and consequences vary for each country.

Agents engage in underground economic activities if they think the benefits of underground operations exceed its costs. Agents go underground primarily to evade taxes, social security contributions and regulations that impose high costs to enter and stay in the official economy. The behaviour of the agents is also influenced by the social norms, the effectiveness of the enforcement system and the quantity and quality of the public goods and services.

On the other hand, agents incur costs when operating underground. These include the loss of legal protection of economic activities, the impossibility to conclude legally binding agreements with suppliers and customers, and the lack of access to diversified sources of financing and to governmental support programmes.

[1] Among which Schneider and Enste (2000), Schneider (2004) and Schneider and Buehn (2009).

The underground economy is frequently blamed for many economic problems, such as poor economic performance, poor quantity and quality of public goods and services, public indebtedness and biased statistics. On the other hand, two of its main causes are inevitable: taxes are needed to finance public policies and regulations are needed to prevent excesses. This inevitability turns the underground economy into a phenomenon that cannot be entirely eradicated. This may give rise to a natural level of underground economic activity.

This thesis assesses the existence of a natural level of underground economic activity. The natural level of underground economy is defined as the level of underground activity that would prevail in the decentralized equilibrium, provided that the actual structural characteristics of the economy and the social preferences are accounted for.

The underground economy has important fiscal repercussions. It erodes the tax base, causing tax losses. Those tax losses affect the quantity and the quality of the publicly provided goods and services. In addition, it may affect the quality of the publicly provided goods and services due to an excess of demand relative to its supply. This is called congestion. Both aspects may affect the sustainability of the fiscal stance and may also explain the outcome of past efforts across the globe to restore fiscal sustainability.

Fiscal sustainability, i.e. whether the debt dynamics is sustainable, may be defined as a policy stance whose continuation in the infinite future does not violate the intertemporal budget constraint. It requires the outstanding stock of public debt to match the present value of the sum of expected future primary balances. If gradual policy changes are sufficient to yield that outcome, the fiscal stance is still considered sustainable. If, on the contrary, drastic policy changes are required, the situation is called unsustainable.

Fiscal sustainability is compatible with the government running primary deficits occasionally. The opposite, namely the government running primary deficits continuously, and as a consequence the successive growth of public debt, might be indicative of the government running a so-called Ponzi-game. Then, the government is rolling over its debt indefinitely and borrowing extra to meet its interest payments.

Extensive research has been done into the variables that determine the outcome of fiscal consolidation. But the role of the underground economy has never been studied. This thesis does; the idea is to assess whether the underground economy adds to the outcome of fiscal consolidation programmes.

Summarizing, this thesis addresses two questions:

1. Is there a natural level of the underground economy?
2. Does it influence the outcome of fiscal consolidation programmes?

These questions are crucial to understand how the underground economy affects the fiscal stance and how to manage it. If the (natural level of) underground economic activity is large and responsible for the lack of fiscal sustainability, fiscal consolidation programmes should address its reduction. Then, the fiscal consolidation strategy should internalize the underground economy.

Hence, the goal of this thesis is threefold:

- Establish a definition for the term natural level of the underground economy.
- Assess the existence of a natural level of underground economy.
- Assess if the underground economy influences the outcome of fiscal consolidation programmes.

This research-subject was chosen for several reasons. First, in the Master's dissertation, Jardim (2007), it was concluded that the fiscal stance in the Netherlands Antilles would turn sustainable if there were no underground economy. That research assumed that turning official would not affect the viability of the activities that were previously conducted underground and that the additional revenues generated by the new official operations would exclusively be used to lower the budget deficit and pay off debt. The assumption of a lower bound different from zero for the size of the underground economy, related to the existence of a natural level of the underground economy, proved still compatible with fiscal sustainability, once the eradication of the underground economy up to that level was accounted for.

Second, until now, research has mainly focused on the determinants of the underground economy and its consequences for the official economy. No attention has ever been devoted to determine the existence of a natural level of underground economic activity, or the role of the underground economy in explaining the outcome of fiscal consolidation programmes.

This research assesses the existence of a natural level of the underground economy. It assesses the relevance of the underground economy in explaining the effectiveness of fiscal consolidation programmes as well. This research also helps the authorities figure out about the position of the economy with regard to critical fiscal thresholds. This research will, therefore, provide useful insight that may improve the process of designing appropriate and optimal fiscal policy guidelines, especially those intended to preserve or restore fiscal sustainability.

This thesis is structured as follows. Chapter 2 starts with a review of the concept of underground economy and establishes its definition in this thesis. Next, it examines its main causes. The underground economy is empirically found to be mainly caused by the overall tax and social security burden, the complexity of the tax and social security system and regulations, the social norms, the effectiveness of the enforcement system and the quantity and quality of the public goods and services.

Chapter 2 proceeds with a discussion about the consequences of the underground economy for the economy as a whole. The underground economy is usually perceived as a negative phenomenon. It is assumed to affect economic growth, distort incentives, distort the allocation of resources in the economy, and to cause the loss of revenue for the state.

The objective of the authorities is to conduct public policies that enhance welfare. Official agents pay taxes and comply with regulations. Underground agents do not. So, underground activities represent less equity and unfair competition. On the other hand, the authorities need the tax proceeds to finance public policies and regulations to prevent excesses. Both cause underground economic activities.

This trade-off may force the authorities to tolerate some underground economic activity. The impossibility to entirely eradicate the underground economy grants it a natural character. Chapter 2 introduces the concept of natural level of the underground economy.

The natural level of the underground economy needs first to be made conceptually operational before its existence can be assessed. Centrally planned economies are very rare, so the authorities try to enhance welfare within the framework of the market-mechanism. The economy is assumed to be operating at its natural level of the underground economy in the market equilibrium, i.e. in the decentralized equilibrium. The authorities pursue the maximization of welfare. But, as noted above, in doing so, the authorities have to tolerate some underground economic activity. The corresponding size of the underground economy is called the natural level of the underground economy.

Starting from the framework provided by the endogenous growth literature[2] two neoclassical general equilibrium models are constructed in Chapter 3 to assess the existence of the natural level of the underground economy. The first model assumes free mobility between the official economy and the underground economy and assumes homogenous agents that may operate simultaneously in both economies. The second model assumes free mobility between the official and underground economies as well, but the agents are heterogeneous. This means that the agents cannot operate simultaneously in both economies. In the second model, an agent belongs either to the official economy or to the underground economy.

The model with homogeneous agents developed in Chapter 3 is calibrated in Chapter 4. This model is chosen because it is closer to the real world. Homogeneity means that the agents may operate simultaneously in both economies, official and underground. It is more likely that economic agents conduct underground economic activities in addition to official operations rather than that they operate exclusively underground.

Next, simulations are performed to assess its adherence and to study empirically the existence of a natural level of underground economic activity. This is done for some developed and developing countries.

[2] Particularly Barro (1990) and Rebelo (1991).

Chapter 5 discusses the interaction between the (natural level of) underground economic activity and the fiscal stance. The underground economy has important fiscal repercussions and affects the sustainability of the fiscal stance, as noted earlier. The underground economy may also explain the outcome of past efforts across the globe to restore fiscal sustainability.

The role of the underground economy in the outcome of fiscal consolidation programmes is studied for the first time in Chapter 5. The analysis in Chapter 5 assesses whether the underground economy helps explain the outcome of fiscal consolidation programmes. This analysis is performed by means of descriptive data analysis and using Probit models. This allows the assessment of the appropriate fiscal consolidation strategy in relation to its impact on the size of the (natural level of the) underground economy.

Chapter 6 summarizes this thesis and draws the main conclusions.

Chapter 2. The natural level of the underground economy

2. 1 Introduction

The underground economy comprises activities that have contributed to value added but that are not contained in the official statistics, apart from the underground economic activities included in the official statistics through imputation. This occurs because they are deliberately concealed from the authorities in an attempt to evade taxes and social security contributions or in an attempt to prevent detection of other infringements.

This chapter starts with a review of the concept of underground economy, its main causes and its consequences for the economy. For a more elaborate but concise discussion Jardim (2007) may be consulted. Next, the concept of the natural level of the underground economy is introduced. The natural level of the underground economy is the level of underground activity that would prevail in the decentralized equilibrium, provided that the actual structural characteristics of the economy and social preferences, including market imperfections, the cost of gathering information about underground activities and fighting underground activities, and the prevailing social norms of tax morale are imbedded in the Walrasian system of general equilibrium equations.

2. 2 The underground economy

Many concepts are employed in the literature related, and sometimes equivalent, to what in this chapter is called the underground economy[3]. Which economic activities are considered part of the underground economy may, however, vary with the scope of the research.

[3] A wide variety of terms are used to refer to the same or different phenomenon, like: underground, unrecorded, unobserved, unreported, informal, subterranean, illegal, clandestine, shadow, hidden, black, grey, second, parallel, off-the-books.

The underground economy is usually related to the deliberate concealment of economic activities from the authorities in an attempt to evade taxes and social security contributions or in an attempt to prevent the detection of other infringements. In order to define and discuss the underground economy, total economic activity is decomposed in two main categories, namely the measured economic activity and the underground economic activity. Economic activities that are not captured in the official figures due to deficiencies in the data collection system are considered residual and further ignored in this thesis.

Definition 1

Measured economic activity concerns economic activity that is recorded by the official statistics.

In accordance with the OECD handbook (2002), the official figures should contain an estimate for unrecorded economic activities. This handbook provides a framework to improve the exhaustiveness of national accounts data by covering all types of under-coverage in the national accounts.

So, the official figures should contain an observed component and an imputed unobserved component as well. The observed component represents the economic activity that is reported to the statistics body, namely the activities that are captured by the data collection system used for the compilation of the national accounts. The unobserved component concerns economic activity that is not captured by the data collection system, including underground activity, and must therefore be imputed.

Definition 2

The underground economy comprises activities that have contributed to value added but that are not included in the official statistics. These economic activities are deliberately concealed from the authorities in an attempt to evade taxes and social security contributions or in an attempt to avoid the detection of other infringements.

This definition closely follows Schneider and Buehn (2009). As mentioned above, the official figures are supposed to account for the existence of underground activities. This imputation does, however, not guarantee that the underground activities are fully accounted for in the official figures. Some economic activity might still be unrecorded which causes the recorded economic activity (official Gross Domestic Product) to differ from total economic activity.

This is confirmed by empirical estimates of the underground economy, as evidenced in Schneider and Buehn (2009), that do not converge to zero and allow, therefore, for the estimation of underground acitivities besides those included in the official figures.

Underground activities used to be associated with developing countries. But empirical research[4] shows that underground activities are a worldwide growing phenomenon and present in less developed countries, and the developed world as well. Table 1 reports some empirical estimates for the size of the underground economy supporting this view.

For instance, according to Schneider and Buehn (2009) the underground economy averaged 13.2 percent of official Gross Domestic Product (GDP) in highly developed OECD countries over the period 1999 - 2000, growing to 16.8% in the period 2002 -

[4] Among which Schneider and Enste (2000), Schneider (2004) and Schneider and Buehn (2009).

2003. Many authors[5] rely on the underground economy estimates by Schneider due to its broad coverage of countries.

Table 1. Underground economy in percentage of official GDP

Countries/Year	Average Size of the underground economy (Number of Countries)		
	1999/2000	2000/2001	2002/2003
Mostly developing countries:			
Africa	33.9 (24)	37.4 (24)	41.2 (24)
Central and South America	34.2 (17)	37.7 (17)	41.5 (17)
Asia	20.9 (25)	23.4 (25)	26.3 (25)
Transition countries	31.5 (23)	34.6 (23)	37.9 (23)
Highly developed OECD countries	13.2 (21)	15.7 (21)	16.8 (21)
South Pacific islands	31.7 (10)	32.6 (10)	33.4 (10)
Communist countries	19.4 (4)	20.7 (4)	21.8 (4)
Unweighted average over 145 countries	33.6	34.5	35.2

Source: Schneider (2004).

Assuming rational agents, the size of the underground economy depends on the comparative benefits and costs of operating underground. Those operating underground perceive its benefits to outweigh its costs. Agents go underground primarily to evade taxes, social security contributions and regulations that impose high costs to enter and stay in the official economy. The latter may include heavy license fees and registration requirements, red tape, and labour and environmental regulations, among others. The behaviour of the agents also depends on the existing social norms, the strength of the

[5] Like Kuehn, (2007), Karlinger (2008), Karlinger (2009), Bovi and Dell'Anno (2009) and Dell'Anno (2009b).

enforcement system and the quantity and quality of the public goods and services. This is further discussed below.

Taxes and social security contributions

Many studies [Frey and Weck (1983), Lippert and Walker (1997), Johnson et al. (1998b), Enste and Schneider (1998), Schneider (1998), Tanzi (1999), Giles (1997 and 1999a), Schneider and Enste (2000), Kuehn (2007), Guillermo (2008), Schneider (2008) and Bovi and Dell'Anno (2009)] conclude that one of the main causes for underground operations are the tax and social security contribution burdens. Rational agents want to maximize their income and assess, therefore, the benefits and costs of evasion. Businesses and individuals in the official economy pay taxes and social security contributions, while agents operating underground do not. This increases the income of the agents operating underground, constituting an advantage for them. The incentives to operate underground increase the bigger the tax and social security burdens.

On the other hand, tax evaders must pay the taxes owed and additionally a penalty, if caught. So the optimal tax evasion of the agents depends negatively on the probability of being caught, the size of the penalty for evasion, and the degree of risk aversion of the agents.

Hibbs and Piculescu (2008) relaxed the traditional view that high tax rates are a major cause of underground activities and established that the incentive of firms to produce underground depends on statutory tax rates relative to firm-specific thresholds of tax toleration rather than on the tax statutory tax rates. These thresholds are determined by the quality of governance and the quantity and quality of available public goods and services and the extent to which firms deem them worth paying for in official operations.

Social norms

Following Schneider (2004), Schneider et al. (2004), Torgler (2007) and Feld and Frey (2007), social norms governing tax morale are defined as the willingness to pay taxes.

It is a pattern of behaviour that is judged by society. An agent complies as long as he believes that compliance is the social norm, while worsening tax morale may lead to increased participation in underground activities. Using data for 19 Latin American countries Dell'Anno (2009a) found a positive relationship between tax morale and tax compliance, i.e. the official economy. Torgler and Schneider (2007 and 2009) too, found evidence that higher tax morale and improved institutional quality lead to a smaller underground economy.

Tax morale may also depend on perceptions of the fairness of the tax system. A tax system that is perceived as equitable may strengthen the social norms against tax evasion. But disapproval of the way taxes are spent may encourage tax evasion, especially if the government is viewed as revenue maximizing. Bird et al. (2006) argue that a sustainable tax system is based on a fair tax system and on a responsive government. This may be achieved through a strong link between tax payments and the supply of public goods and services.

Systemic corruption and government budgets that lack transparency undermine the willingness to pay taxes. If citizens feel that their interests are properly represented in political institutions, their willingness to operate underground diminishes. The opposite applies in a corrupt state. For instance, according to Schnellenbach (2006) taxpayers adjust their tax compliance according to their satisfaction with public policy, processes of collective decision-making, and the quality of their relationship with the authorities.

Social norms that stigmatize deviant behaviour, when detected, discourage operating underground. The probability of detection depends on the overall government effectiveness. But, as argued by Rosser et al. (2003), a large underground economy lowers the tax proceeds, hence limiting the resources available to enforce compliance to the rules. The social norms may also influence the tolerance by the authorities and determine the resources devoted to fight deviant behaviour.

Intensity of regulations

Many studies [Frey and Weck (1983), Friedman et al. (2000), Schneider (2004), Schneider et al. (2004), Guillermo (2008), Schneider (2008) and Torgler and Schneider (2007)] conclude that a third source for underground operations is the existence of burdensome and costly government regulations.

There are several reasons for the government to regulate business activity, like to ensure the health and safety of its citizens (employees and consumers) and clean environment. State regulation also helps contain the growth of criminal activities. On the other hand, some regulations just foster bureaucracy, involving burdensome procedures without adding any value to the final purpose. In that case, the same outcome could be achieved by means of a simplified regulatory framework or no regulation at all.

It is not the extent of regulation, but the determination with which it is enforced, that drives agents underground. If enforcement is poor, the agents may not experience regulations as a burden when doing business officially. Then, regulations do not impose extra costs to the agents. But if regulations are really enforced, imposing costs on the agents and consequently affecting their income, agents might be more inclined to operate underground.

Public goods and services

Some studies [Johnson et al. (1998a, 1998b) and Bird et al. (2006)] conclude that poor quality and quantity of publicly provided goods and services[6], in addition to high tax rates, encourage underground operations. Under such circumstances, the willingness to pay taxes decreases since this burden is not recovered through publicly provided goods and services. For instance, Schneider (2008) found that for Germany an increased tax burden (including social security) and intensive labour market regulation, combined with poor quality of state institutions and low tax morale, expand the underground economy.

Because the underground economy takes away resources from the state and causes congestion, it may deteriorate the quality and quantity of publicly provided goods and services, aggravating this perception. Increasing taxes in order to cope with the lack of financial resources may then further strengthen the incentives to operate underground.

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[6] The term public goods and services is used throughout this whole section. It is therefore important to establish its definition here. Two kinds of public goods and services may be distinguished: pure and impure. Pure public goods and services are, contrary to private goods and services, non-rival. This means that, once provided, those public goods and services may be consumed by more individuals without additional costs or without affecting the ability of others to consume them or get satisfaction from them. In addition, pure public goods and services are usually non-excludable. This means that it is not possible to prevent anyone, who is not willing to pay for it, from consuming it.

Non-excludability may cause congestion. This means that, whenever the same constant amount of public goods and services is used by an increasing number of agents, the quality of the public goods and services is affected. The satisfaction each individual extracts from its consumption is then affected, because the demand is not matched by the supply. This challenges the non-rivalness property. As a consequence, impure public goods and services arise. Impure public goods and services are to some extent rival. For a more elaborate treatment of this subject please be referred to Rosen (1999) and Stiglitz (2000).

Other lines of research, like performed by Karlinger (2008), suggest that increased market competition drives firms into the underground economy. The reasoning is as follows: a firm operating underground hires its inputs at lower prices, relative to a firm operating in the official economy, because it evades taxes and disregards regulations (safety, health, and etcetera). The underground firm can, therefore, better afford to reduce its prices. That puts the official firm at a competitive disadvantage forcing it to choose between operating underground as well, or going out of business. The fiercer the competition, the greater the pressure to reduce costs gets and the more likely that agents go underground.

More recently, Karlinger (2009) relaxed this conclusion somewhat as empirical evidence indicates the positive relationship between market competition and the size of the underground economy is stronger in countries characterized by low taxes and high corruption indices that do not provide the proper public goods and services. Countries with high public revenues and low corruption can offer high-quality public goods and services which makes it more attractive for firms to remain official even when competition increases.

The benefits of operating underground mentioned above correspond with costs of operating officially. But going underground also poses disadvantages to the agents, because some benefits of operating officially are lost. These are the costs of operating underground.

If detected, underground activities may face fines or even property confiscation. Furthermore, underground agents do not fully benefit from public goods and services, especially those that protect their property rights. For instance, underground agents are not adequately protected by the judicial system against crimes committed against their property. Underground agents cannot enter either into legally binding agreements, which increases uncertainty for their businesses. They are also deprived from government-supported credit facilities and skill training programs. Their access to capital and insurance markets is also strangled. This limits their tools to manage risk and imposes credit constraints, hindering them from using more advanced, but simultaneously more expensive, technology.

Larger and more capital-intensive firms are easier to detect by the authorities and hence more difficult to operate underground. Since underground agents organize their operations in a way to prevent detection, this might force them to scale down the size of their operations. This prevents them from achieving economies of scale and from choosing an optimal capital-labour ratio. This may explain why they use to be less capital intensive. This affects their profit potential.

In summary, the costs are among others the loss of legal protection of economic activities, the incapability to conclude legally enforceable agreements with suppliers and customers, and the lack of access to diversified sources of financing and government support programmes.

The value of these advantages for those operating officially depends, however, on the effectiveness of the judicial system [Friedman et al. (2000)]. Dabla-Norris et al. (2008) also found that the quality of the legal framework is crucial for the size of the underground economy. If the benefits are not really enforceable, due to a weak legal system or corruption, these advantages are not materialized. Then, the incentives to remain in the official economy are in fact limited. According to Dabla-Norris et al. (2008), the role of the tax burden and regulations in explaining the size of the underground economy is limited in the context of a well-functioning legal system.

In this line of research, Buehn and Schneider (2009) present empirical evidence of a positive relationship between the underground economy and corruption. Corruption is closely related to the functioning of the legal system as a disfunctioning legal system provides fertile grounds for corruption.

So, a way to enhance the benefits of operating officially is through the improvement of the functioning of law and justice. But the strength of the legal system also depends on the resources available to the authorities. A large underground economy limits the resources available to set up and maintain a strong legal system. This conditions the real benefits of operating officially. If the improvement of the legal system induces agents to switch from the underground economy into the official economy, tax revenues increase. The increase of the revenues provides the financial means necessary for the further improvement of the legal system, hence consolidating this trend.

Economies with relatively fair taxes, adequate regulation, appropriate provision of public goods and services, and properly functioning judicial systems should have a small underground economy. On the other hand, countries with unfair taxes, extensive regulation, poor public goods and services, and malfunctioning judicial systems are expected to have larger underground economies.

Interaction with the official economy

The underground economy is usually perceived as a negative phenomenon as it is assumed to affect economic growth, to distort incentives and the allocation of resources in the economy, and to cause the loss of revenue for the state.

The literature presents several views on the interaction between the official economy and the underground economy. Some studies [among which Giles (1999b) and Alañón and Gómez-Antonio (2005)] conclude that there is a positive correlation between the official economy and the underground economy. This occurs when the income effect prevails, which means that goods and services produced in the underground economy are being consumed in the official economy. In this case, a downturn in the official economy reduces the demand for those goods and services, hence shrinking the underground economy as well. This implies that, in terms of total economic activity, the movements in the official economy are amplified by the movements in the underground economy.

From this perspective, an expanding underground economy stimulates the official economy as at least some of the additional income earned in the underground economy is spent in the official economy. This explains the general view that underground activities mostly affect direct tax revenues and that they have a less pronounced impact on indirect tax revenues.

On the other hand[7], a contraction of the official economy may be related to a shift from production of goods and services in the official economy to production in the underground economy or a shift from demand for goods and services produced in the

[7] Enste and Schneider (1998), Schneider and Enste (2000), Eilat and Zinnes (2000), Dell'Anno (2003) and Feige and Urban (2003).

official economy to goods and services produced in the underground economy. This is called the substitution effect. In this case, the official economy and the underground economy exhibit a negative correlation. Then, in terms of total economic activity, the underground economy dampens business cycles in the official economy.

Underground activity can constrain private investment and growth, because businesses operating underground are frequently deprived from access to formal credit markets and from access to market-supporting institutions, like the judicial system, to enforce legal contracts. Once deprived from access to these facilities and services, investment in the economy as a whole may be affected, reducing the production and growth potential of the economy.

Since agents operating in the underground economy face relative input and output prices different from those operating in the official economy, allocation and distribution are distorted as well. This might cause excessive resources to be allocated to economic activities particularly suitable to take place underground, affecting the structure and the efficiency of the economy, and it might also induce unfair competition between official and underground agents. This might turn official agents, which under normal circumstances would be viable, unviable.

Tax evasion compromises the equitable sharing of the tax burden, through horizontal inequity, because it causes equally well off agents to face different effective tax burdens. Since tax non-compliance shifts the burden away from the dishonest to the honest taxpayers, the costs of operating officially increase. Consequently fewer agents are willing to remain in the official economy, because those who remain face (relatively) higher taxes. As a consequence, the official economy shrinks, and so do public revenues.

This means that underground activities erode the tax and social security bases, limiting the financial resources available to the state and contributing to higher deficits. This limits the capability of the state to provide the proper quantity and quality of public goods and services. This way, the underground economy negatively affects economic growth by affecting the availability or the quality of public goods and services, and by leading to the less efficient use of the existing public goods and services (congestion). Therefore, the underground economy is believed to reduce tax revenues and induce relatively poorer quantity and quality of public goods and services. This affects economic growth.

The tax base any state needs to manage its economy is eroded by the underground economy, making it harder to achieve and preserve macroeconomic stability. Further on, the legitimacy of the overall legal system is challenged due to the restrictions it exerts on the financial means necessary for its financing. This way, the underground economy poses serious concerns to the ability of the state to manage the economy and to establish the rule of law.

2. 3 The natural level of the underground economy

From many perspectives, the underground economy is not beneficial for economic growth, when compared to an economy with no underground activities. For example, while people working in the underground economy benefit from public goods and services, like education and infrastructure; they do not contribute to their financing. The eradication of the underground economy could lead to a broader tax base and make it feasible to lower the overall tax-burden or to improve the quantity or the quality of public goods and services. This could improve the growth prospects of the economy.

The underground economy also attracts agents away from the official economy and distorts the allocation of the resources in the economy and the competition for official firms. The competition faced by official firms is distorted, because they have to compete side by side with underground firms that do not comply with regulations nor do pay taxes. Hence, the official firms face unfair competition from the underground firms.

That is why the underground economy is frequently blamed for many economic problems, such as poor quantity and quality of public goods and services, high public debt, and biased unemployment figures.

Since underground activities are not fully recorded, official statistics do not accurately represent the true state of the economy. Given that statistics, like unemployment, inflation and income, are employed to design economic policy, inaccurate figures may lead to inadequate policy design and implementation as well[8]. Inaccurate statistics may also have political implications. For example, official Gross Domestic Product (GDP) figures are frequently part of the formula to determine the voting rights and obligations towards international institutions, like the International Monetary Fund, the World Bank and the European Union.

Further on, the underground activities are forced to operate in an inefficient way, e.g. small scale, in order to avoid detection. Their small scale hurts their competitiveness and hinders them from gaining relevant market shares due to the lack of productive capacity. Their small scale may also prevent them from adopting the appropriate production procedures, affecting the overall efficiency of the economy and leading to a welfare loss.

[8] Bhattacharyya (1999), Tanzi (1999), Bloem and Shresha (2000) and Fleming et al (2000).

Considering these disadvantages, the legitimate question that arises is: Why do the authorities tolerate underground activities, i.e. why do the authorities not pursue the extinction of the underground economy? Or do the authorities pursue this goal, without success? Next, this matter is further discussed.

In this context, it is important to realize that the underground economy exhibits some specific advantages. For instance, it provides fundamental goods and services that might else not be produced. It may also serve as a survival mechanism by providing employees with basic subsistence means, especially in developing countries. In addition, if the underground economy results from overburdening by taxes, social security contributions and regulations, the activities taking place underground would probably not survive if forced to operate officially.

The underground economy may, therefore, also be interpreted as an indicator of inadequate economic policies or as resulting from the failure of the authorities to foster an efficient economy. From this perspective, the underground economy represents a response to the economic environment, mainly constraints in the official economy, and it supplies the economy with the necessary tools or conditions to enhance dynamism and entrepreneurship. That way it contributes to improving the social well-being.

In addition, in corrupt states bureaucrats may profit from underground activities and they might therefore create an environment propitious to underground activities.

Eradication of the underground economy may require stricter regulations. Stricter regulations may require extra financing. This financing need may be covered by increasing taxes or by using some of the actual tax proceeds, which can consequently no longer be used to finance the current provision of public goods and services. Since regulations, taxes and the quantity and quality of public goods and services are assumed to be the main driving forces behind underground activities, this may reinforce the incentives to operate underground. This supports the view expressed in Dabla-Norris and Feltenstein (2005) that an affordable tax program, necessary to finance public policy, inevitably causes underground activities.

Based on the above, the underground economy may be perceived to be a phenomenon that cannot be entirely eradicated. This may give rise to a natural level of underground economy. Closely following the structure as adopted by Friedman (1968), the natural level of underground economy is defined as follows.

Definition 4

The natural level of underground economy is the level of underground economic activity that would prevail in the decentralized equilibrium, provided that the actual structural characteristics of the economy and social preferences, including market imperfections, the cost of gathering information about underground activities and fighting it, and the prevailing social norms regarding tax morale, are imbedded in the Walrasian system of general equilibrium equations.

By no means does this suggest that underground activities should be left untouched. The level of underground activities in a country may be related to its natural level of underground economy. Countries with more underground activities, associated with a larger natural level of the underground economy, should reflect about its structural causes, because those causes may also be affecting the overall economic performance.

If the way the state intervenes in the economy is the main reason for the existence of the underground economy, efforts to reduce the size of the underground economy should address the governmental intervention in the economy. This involves increasing the benefits and reducing the costs of official activity, hence limiting the incentives to operate underground. This may be achieved through better public goods and services and a sounder official economic environment, while simultaneously enforcing compliance to regulations. This may ultimately lead to a lower natural level of the underground economy as well.

Like the underground economy itself, the natural level of the underground economy in a country might, to a large extent, be determined by its institutional matrix that includes, among others, social norms and views regarding the functions of the state. Some societies tolerate or even value tax evasion, while it is disapproved in other societies. That determines the size of the (natural level of the) underground economy.

It is also important to acknowledge that individuals may not necessarily value public goods and services the same way. Some citizens value particular public goods or services, like for instance a new generation of fighters, because they think this will contribute to the safety of their nation. Other citizens dislike it, as they believe it may induce their neighbours to increase defense expenses, which affects the security of their nation.

So, different levels of underground economic activities may be natural, but the natural level of the underground economy should not affect the ability of the state to conduct a sound macroeconomic policy, nor affect fair competition.

The terms natural unemployment and natural level of the underground economy

The term natural level of the underground economy resembles another term, commonly used in economics, namely the natural rate of unemployment. Friedman (1968) defined the natural rate of unemployment as follows: *"The natural rate of unemployment is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on."*

The economy is then operating at full employment. Full employment does not mean that there is no unemployment at all. Full employment means that the economy is operating at its full capacity and that there is no unemployment caused by lack of demand. Whenever there is a shortage of demand, expansionary policies may move the economy to this point of full employment. The corresponding unemployment is caused by supply side factors rather than demand side factors. It is called the natural rate of unemployment, as mentioned earlier.

The natural level of the underground economy

The objective of the authorities is to conduct public policies that enhance the well-being of its citizens. Official agents pay taxes and comply with regulations. Underground agents do not. So, underground activities represent less equity and unfair competition. It makes, therefore, sense to assume that the authorities try to minimize the size of the underground economy in order to enhance the well-being. But these goals may conflict.

On the one hand, full pledge to the goal to minimize the size of the underground economy may affect the economic environment in such a way that the outcome is less well-being, while on the other hand unbearable social differences may arise. Faced with this trade-off, between the size of the underground economy and the well-being, the authorities have to balance these objectives and determine their policies such that the overall economic performance does not get disrupted and that the society, as a whole, reaches the highest possible well-being. The authorities will then settle at the natural level of the underground economy.

Similar to the natural rate of unemployment, the natural level of the underground economy responds to structural policies governing supply side factors, i.e. institutional factors, like the tax system, the regulatory framework, the quantity and the quality of public goods and services, and the social norms and beliefs. The trade-off mentioned earlier is illustrated next.

Stricter enforcement of the tax and regulatory regime may contribute to a smaller underground economy. This may also enhance fair competition and improve economic performance, generating in the long-run additional resources to provide more or better public goods and services, or allow tax cuts. These are beneficial for the economic environment and the well-being as well.

But, stricter enforcement may require additional resources. If the additional resources are levied through tax increases, the incentives to operate underground increase, because the tax burden is one of the main structural causes of underground activities. So, this may cause in the long-run both, the underground economy and its natural level, to expand. Higher taxes affect the disposable income, hence the purchasing power, and may therefore affect the well-being.

The same applies if stricter enforcement is financed with the actual tax proceeds, because this leaves fewer resources to finance the provision of public goods and services. This may affect their current quantity and quality, which is also one of the main structural causes of underground activities. So, this may cause in the long-run both, the underground economy and its natural level, to expand. This effect on the quantity and the quality of public goods and services may affect the economic environment and the well-being too.

Reducing taxes to turn underground activities less attractive, may contribute to shrink the (natural level of the) underground economy in the short-run. The disposable income, hence the purchasing power, benefits from lower taxes. This may therefore improve well-being.

But if the tax cut affects the quantity and or the quality of the public goods and services as a consequence of the lack of financial resources, it may cause both, the underground economy and its natural level, to increase. This effect on the quantity and the quality of public goods and services may hurt the economic environment and the well-being as well.

Relaxing (the enforcement of) regulations may improve the business environment, making it less attractive to operate underground. This may cause the underground economy and its natural level to shrink in the short-run. This may also improve the economic environment and the well-being. But it may lead to less well-being as well, because the agents might no longer feel protected due to, for example, the exposure to unsafe or inhumane working conditions and the destruction of the environment.

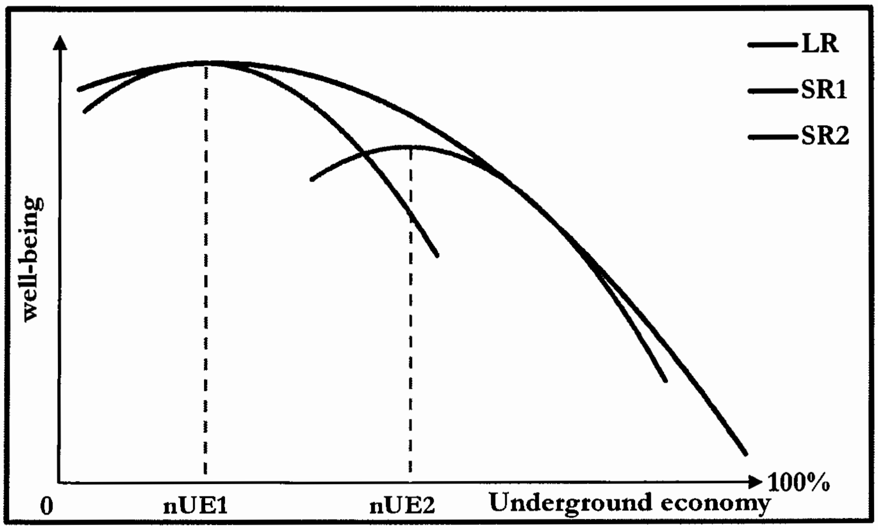
The discussion above suggests that structural policies may have a temporary and a lasting effect on the size of the (natural level of the) underground economy. It also suggests that structural policies that contribute to reduce both, the underground economy and its natural level, may, passed a threshold, strengthen the incentives to operate underground, increasing both, the underground economy and its natural level. The same applies to its consequences for the well-being.

This discussion establishes scope, in the short-run and in the long-run, to increase the official economy and the well-being simultaneously, and scope for a trade-off. Since the total economy comprises official economic activities and underground economic activities, the same applies to the underground economy and the well-being, in the sense that when the official economy and the well-being exhibit a positive relationship; the underground economy and the well-being exhibit necessarily a trade-off, and vice-versa.

It is obvious that it is more difficult to establish this relation when the structural policies are directed towards influencing or changing social norms and beliefs. In particular, because it is more difficult to design this kind of policies and because this kind of policies may have more lagged effects.

This discussion is translated into the hypothetical relationship depicted in Figure 1. The co-movement and trade-off relationship between the underground economy and the well-being translates into a cut-off inverted U-shape relationship between the size of the underground economy and the well-being, in the short-run and in the long-run. Structural policies that target the reduction of the underground economy may have positive short-run and long-run effects on the underground economy and its natural level up to a certain threshold. Passed that threshold, the reduction of the underground economy might involve such high costs that the well-being starts declining. The level of underground economic activity associated with that kind of thresholds corresponds with the natural level of the underground economy. These thresholds are graphically represented in Figure 1 by turning-points. nUE1 represents the natural level of the underground economy in the short-run and simultaneously the natural level of the underground economy in the long-run. nUE2 represents another natural level of the underground economy in the short-run.

Figure 1. Derivation of the natural level of the underground economy



This explains why the authorities, while trying to reduce the size of the underground economy, might be forced to tolerate some underground economic activity. They have to reconcile the goal of equity and fair competition, as inversely measured here by the share of underground economic activity in total economic activity, with overall well-being. Underground economic activity should be extinguished up to the point where well-being increases and from where well-being starts declining.

The final outcome regarding the natural level of the underground economy and the well-being depends on the policy mix deployed. The policy mix causes the short-run curve (SR_i) to shift and the economy to move along the long-run curve (LR). This does not tell which policy mix minimizes the size of the natural level of the underground economy and whether the natural level of the underground economy equals zero at the threshold.

Maximizing the well-being may indeed not necessarily mean that there is no underground economic activity. Several factors may prevent the economy from ever reaching a point where there is no underground sector, like:

- Taxation. Taxes affect the income of agents and represent an incentive to operate underground, since underground agents pay no taxes. There will always be taxes, because the authorities need resources to conduct public policies, such as social security, justice, police and defense.
- Regulation. Regulations affect the income of agents and may even affect the viability of official activities, because compliance may involve additional costs. This favours underground activities, because they do not have to comply with regulations. There will always be rules and regulations, e.g. to protect workers from exploitation and against unsafe working conditions, and environmental regulations to guarantee a sustainable development.

Worldwide the size of the underground economy is smaller in the developed world, as shown in Table 1. This may be associated with smaller natural levels of the underground economy. This feature might be captured in Figure 1 as well, by associating the short-run curve - SR1 - with the developed world and the short-run curve - SR2 - with the developing world.

Determinants of the (natural level of the) underground economy and policies to reduce it

In the long-run, structural policies targeting the supply side of the economy and the social norms and beliefs, are required to reduce the size of the (natural level of the) underground economy, in harmony with well-being. Which policy mix is appropriate remains, however, an issue.

Policies to reduce the size of the (natural level of the) underground economy should focus on, for example:

- Reform of the tax system by lowering tax rates and simplifying the tax framework.
- Reform of the regulatory framework, making it more transparent, by removing the unnecessary ones and simplifying the necessary ones.
- Reform of the public decision procedures and paradigms in order to enhance the quantity and the quality of public goods and services and the transparency.
- Information campaigns to educate citizens and influence their views about taxes, regulations, public goods and services, and underground economic activities.

Possible criticism of the natural level of the underground economy

The term natural level of the underground economy may, like the term natural rate of unemployment does, erroneously suggest that a certain amount of underground economic activity is acceptable. Throughout this chapter no opinion is expressed in favour of the existence of underground economic activities. It is only stated that several factors cause underground economic acivities and grant them an inevitable, i.e. natural, character.

The term may also erroneously suggest that it is a fixed figure. It is not and it may change over time, like for instance the size of the underground economy and the natural rate of unemployment do.

The view about the existence of a natural level of the underground economy may also be criticized based on the assumption that there are factors causing underground economic activities other than those considered here. For instance, it may be argued that the level of education might as well explain the existence of underground economic activities. Lower levels of education are then more likely to be related with underground economic activities as a mean of survival.

That might imply that a policy mix, tackling the aforementioned aspects (tax system, regulatory framework, quantity and quality of public goods and services and social norms and beliefs), does not address the issue properly. That may also explain the hypothetical inverted U-shape relationship graphed in Figure 1. But this does not prove that there is no natural level of the underground economy.

The policy mix may also be inappropriate because it is very difficult to assess the preferences of the agents, i.e. the way the agents value equity and other aspects is not directly observable; and it is therefore difficult to change the size of the natural level of the underground economy. That may explain the hypothetical inverted U-shape graphed in Figure 1.

The preferences are not static, i.e. they may change over time. The views of an individual may change over time and the views may also differ between generations. This makes it difficult to assess and design the appropriate policy mix to address the underground economy and may explain the hypothetical inverted U-shape as graphed as well. It may also be argued that preferences are not static in the sense that they may also change in reaction to the policy implemented. This might occur because it is expectable that social norms react to policy. The social norms may be moderated or strengthened depending on the extent to which the policy is capable of moulding them, and the way the policy is perceived by the public. It is therefore necessary for the authorities to constantly monitor the evolution of the preferences and adjust its policy accordingly.

In summary, this criticism may challenge the effectiveness of the policy mix chosen to address the underground economy, and therefore the hypothetical inverted U-shape relationship as graphed in Figure 1. But it does not prove that there is no natural level of the underground economy. Moreover, there will always be taxes and regulatory frameworks, as noted earlier, which as broadly proven in the literature [Frey and Weck (1983), Lippert and Walker (1997), Johnson et al. (1998b), Enste and Schneider (1998), Schneider (1998), Tanzi (1999), Giles (1997 and 1999a), Friedman et al. (2000), Schneider and Enste (2000), Schneider (2004), Schneider et al. (2004), Kuehn (2007), Torgler and Schneider (2007), Guillermo (2008), Schneider (2008) and Bovi and Dell'Anno (2009)] are responsible for the existence of underground economic activities. Since there will always be underground economic activities a certain level of the underground economic activity might be considered natural.

Estimating the natural level of the underground economy

In this thesis a structural, i.e. modeling, strategy is employed to determine the natural level of the underground economy rather than statistical methods, commonly used when estimating the natural rate of unemployment. A neoclassical general equilibrium model will be constructed in Chapter 3 to assess the existence of the natural level of the underground economy.

Chapter 3. Modelling the natural level of the underground economy

3. 1 Introduction

The authorities conduct public policies to enhance the well-being of their citizens. Underground activities are related to less equity and unfair competition, because official agents pay taxes and comply with regulations, while underground agents do not. Therefore, minimizing the size of the underground economy should contribute to enhance welfare. But these goals may conflict, as noted in Chapter 2.

Centrally planned economies are very rare, so the authorities should try to enhance welfare within the framework of the market-mechanism. In Chapter 2 the concept of natural level of the underground economy was introduced and defined, as follows: "The natural level of underground economy is the level of underground activity that would prevail in the decentralized equilibrium, provided that the actual structural characteristics of the economy and the social preferences, including market imperfections, the cost of gathering information about underground activities and fighting it, and the prevailing social norms of tax morale, are imbedded in the Walrasian system of general equilibrium equations."

The operationalization of this concept requires some further assumptions. In particular, from an underground economy perspective, the economy is assumed to be operating at its natural level in the market equilibrium, i.e. in the decentralized equilibrium. The authorities are constantly trying to influence or move the decentralized equilibrium to a position compatible with higher levels of welfare. But, as noted in Chapter 2, in doing so, the authorities have to tolerate some underground activity. The corresponding size of the underground economy is called the natural level of the underground economy.

The economy is rarely in equilibrium. Market forces, like shocks, keep the economy away from its equilibrium. It is also expectable that, if the authorities are pursuing the reduction of the size of the underground economy, within the market mechanism, in order to enhance welfare, then the observed size of the underground economy is larger than in the decentralized equilibrium. This may happen because the authorities:

- account for the congestion of public goods and services, that results from their use by underground agents;
- account for the loss of tax proceeds, that results from underground activities that are not taxed; and
- account for the social unfairness that is associated with underground activities.

In the next section, the existence of a natural level of underground economic activity is assessed. For this purpose, a simple general equilibrium model is constructed. The existence of a natural level of the underground economy and its size can be assessed using this model, as it proxies the definition adopted in Chapter 2 for the natural level of the underground economy. In this model the structural characteristics of the economy and the social preferences are accounted for through production and utility functions. Markets are assumed competitive and market imperfections are ignored, including the costs of gathering information about underground economic activities and fighting underground economic activities, as in this model the public revenues are fully devoted to supply public goods and services. Like Friedman (1968) no Walrasian system of general equilibrium equations is used as it cannot be operationalized. This model is modified in the third section to introduce heterogeneous agents. The fourth section resumes the main conclusions.

3. 2 A neoclassical general equilibrium model with underground activities and homogeneous agents

Following the proposition of the previous section that a certain level of underground economic activity may be natural, its existence is now formally assessed. A neoclassical general equilibrium model is constructed starting from the framework provided by the endogenous growth literature[9] to assess the existence of a natural level of underground economic activity.

The economy has two sectors: the official economy and the underground economy, which are modelled explicitly. The agents optimize their benefits and decide, accordingly, how to allocate their resources between the two sectors.

Only official activity is observed by the authorities and taxed in the form of a proportional income tax. The proceeds of taxes are used to finance the provision of public goods and services.

Underground economic activities go undetected, hence not taxed, which implies fewer resources for the authorities, imposing tighter fiscal constraints. Underground agents do not pay taxes, but they incur income losses due to their underground nature: (1) they have only limited access to public goods and services, (2) they have to pay penalties if discovered, (3) they may have to pay the 'mafia' for protection, (4) they face constraints when choosing the production technology in order to prevent detection and (5) they do not have full access to capital and insurance markets.

[9] Particularly Barro (1990) and Rebelo (1991).

Proceeds from penalties are assumed to serve solely to finance the enforcement system. So, these proceeds are not used to pay for the provision of public goods and services.

Following Barro and Sala-I-Martin (1992), the impact of government actions on production is considered here explicitly. They present three versions of the model developed in Barro (1990) for the inclusion of public goods and services in endogenous growth models.

They consider: (1) publicly provided private goods and services, which are rival, i.e. subject to congestion, and excludable, i.e. not free to use by everyone, (2) publicly provided public goods and services, which are non-rival and non-excludable, and (3) publicly provided goods and services that are rival, but to some extent excludable, i.e. agents can use only limited amounts of them.

Many public goods and services are rival and to some extent non-excludable. Many may even be used when the agents are not operating officially. When the agents are operating underground they lack access to public goods and services that might be vital or important to their professional or entrepreneurial performances. But they still benefit from the public goods and services as citizens.

For instance, agents may use toll-free high ways, they may use the social security system to cover their medical expenses or for some basic pension schemes, and they benefit from the judicial system when crimes are committed against their physical integrity. These examples have in common that the use of public goods and services is not related to any professional or entrepreneurial activity, but to the individual citizens.

But since the resources necessary to supply them, i.e. the tax proceeds, are generated only by official activity, there might not be enough resources to supply them in the quantity and the quality necessary for the society as a whole, i.e. including the agents when operating underground. This issue might arise even when the underground agents turn official. So, assumptions must be made regarding the scope to improve the efficiency of public spending and about the incremented official sector generating sufficient additional resources to improve the quantity and the quality of the public goods and services.

Underground agents do not pay for public goods and services, but they congest them. As a result, the non-rivalness of the public goods and services is challenged: the lack of resources affects the quantity and the quality of the public goods and services, because they get congested; this affects the ability of anyone to consume them or get satisfaction from them. So, the (partial) access to public goods and services by the underground agents may be a source of congestion that challenges non-rivalness.

That is why it is argued that on the aggregate the third version mentioned earlier best represents the situation in the real world. The model will, therefore, be constructed along the lines of the latter. Braun and Loayza (1994) and Loayza (1997) adopted the same strategy. Braun and Loayza (1994) built a dynamic model in which informal activity arises from high taxes and high entry costs to the official economy, co-existing with an inefficient and corrupt compliance system. Loayza (1997) studied the determinants and effects of the informal economy using an endogenous growth model whose production depends essentially on congestable public services. He concluded that changes that increase the relative size of the informal economy also reduce the economic growth rate.

The economy is further characterized as follows in the model:

- There are two sectors: official and underground.
- There are three agents: the representative household, the representative firm and the fiscal authority.
- The representative household maximizes its utility subject to its budget constraint.
- The representative firm maximizes its profits subject to technology and capital accumulation dynamics.
- Labour costs enter the model via the budget constraint of the representative household.
- The fiscal authority (government) raises taxes and supplies public goods and services.
- There is free mobility across sectors, i.e. the representative agents may operate simultaneously in both sectors.
- Agents pay taxes when operating officially.
- Agents do not pay taxes when operating underground. But they suffer income losses due to measures taken to keep their activity undetected.
- Official agents have full access to public goods and services, and to capital and insurance markets, while underground agents have limited access.
- The tax proceeds from the official activity are used to finance the provision of public goods and services.
- There are competitive goods and factor markets.
- The economy is closed and its interest rate is determined endogeneously.

Representative household

An economy populated by equal, infinitely-lived households is assumed. The population is constant and given exogenously. Each household has one member and is endowed with equal starting levels of assets. The representative household chooses consumption and how to allocate its resources in order to maximize lifetime utility.

Lifetime utility is given by

(1) $U = \int_0^{\infty} u(c(t))e^{-\rho t}dt$

where u(c(t)) is the utility function, c(t) is consumption per household, and $\rho > 0$ is the constant rate of time preference.

The utility function is given by $u(c(t)) = \frac{c(t)^{1-\theta} - 1}{1-\theta}$, where $\theta > 0$ and where θ is the coefficient of relative risk aversion with respect to c(t). The constraint imposed on θ is necessary to ensure that the utility function is concave in c(t). This utility function satisfies the usual properties: it is concave in c(t), twice differentiable and well behaved.

The budget constraint of the representative household determines the change over time in assets to be:

(2) $\dot{a}(t) = (1-\tau)y^{o}(t) + (1-\lambda)y^{u}(t) + ra(t) - c(t)$, $0<\tau<1$ and $0<\lambda<1$.

where a(t) is the quantity of asset endowments per representative household. $(1-\tau)y^{o}(t)$ is the net labour income earned in the official economy by the representative household. τ is the tax rate. $(1-\lambda)y^{u}(t)$ is the labour income earned in the underground economy. The agents need to undertake measures to keep their activity undetected when they are operating underground. The parameter λ captures the income losses the agents incur when operating underground. Finally, r is the real rate of return on assets.

Representative firm

The representative firm faces perfect competition and produces a composite, homogeneous good with a Cobb-Douglas production technology. This single good can be either consumed or invested. The good produced underground cannot be distinguished from the one produced in the official economy.

The representative firm may operate simultaneously in both sectors. So, its profits are given, as follows:

(3) $\Pi(t) = (1-\tau)y^{o}(t) + (1-\lambda)y^{u}(t) - i^{o}(t) - i^{u}(t)$

where $\Pi(t)$ stands for profits. $(1-\tau)y^{o}(t)$ is the net income from official production and τ is the tax rate. $(1-\lambda)y^{u}(t)$ is the income earned from underground production. The parameter λ represents the losses the firm incurs when it is operating underground. These losses are related to measures to keep the underground activity undetected. $i^{o}(t)$ is the gross investment by the representative firm in its official operations and $i^{u}(t)$ is its gross investment in its underground operations.

The access of the representative firm to public goods and services depends on whether it is operating in the official sector or in the underground sector. When operating in the official sector, the firm enjoys full access to public goods and services. When operating in the underground sector, the firm has limited access. The limited access to public goods and services is explained by the need to prevent detection. Else, if detected by the authorities, it would be forced to pay taxes and to comply with the regulations. For instance, the firm does not enjoy protection by the judicial system, in its underground operations, when faced with a crime against its underground production capacity.

Let's assume g(t) represents the flow of public goods and services the representative firm enjoys. This relates of course to the total flow of public goods and services, represented by G(t). g(t) equals the total flow of public services, G(t), when the firm is operating in the official sector, because then it has full access to public goods and services. g(t) is then represented by g'(t). In contrast, g(t) is only a fraction (γ) of G(t) when the firm is operating underground, because then it has limited access to public goods and services. g(t) is then represented by g''(t). This is given by the following equation:

$$(4)\quad g(t) = \begin{cases} g'(t) = G(t) & \text{when the firm is operating official} \\ g''(t) = \gamma G(t) & \text{when the firm is operating underground} \end{cases}$$

where $0<\gamma<1$ stands for the share of public goods and services that is accessible to the firm when it is operating underground.

The technology exhibits decreasing returns to capital and to public goods and services as a share of aggregate capital $\left(\frac{g}{K}\right)$. The production function in the official sector is given by

$$(5)\quad y^{o}(t) = A\left(\frac{g'(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha} = A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha}, 0 < \alpha < 1$$

where A is a productivity parameter given exogenously. This parameter depends on the technology adopted by the firm. $y^{o}(t)$ and $k^{o}(t)$ are the official output and capital of the representative firm, respectively. g'(t) is the flow of public goods and services the representative firm enjoys in its official operations. As noted earlier, the firm has full access to the publicly provided goods and services, when it is operating in the official sector, hence g'(t) equals the total flow of public goods and services, G(t). K(t) is the total stock of capital in the economy (official and underground). α stands for the contribution of public goods and services to official output as a share of total capital.

The production function in the underground sector is given by

$$(6)\quad y^{u}(t)=B\left(\frac{g''(t)}{K(t)}\right)^{\beta}k^{u}(t)^{1-\beta}=B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}k^{u}(t)^{1-\beta},\ 0<\gamma<1$$

where B is the underground productivity parameter which is given exogenously. This parameter depends on the technology adopted by the representative firm for its underground operations. Firms are constrained in their technology choices when they are operating underground, in order to prevent detection. This affects productivity causing B to be smaller than A (B<A). $y^u(t)$ and $k^u(t)$ represent the output and capital of the representative firm when operating underground, respectively. As noted earlier, the representative agent does not have full access to public goods and services when operating underground in order to prevent the detection of those activities. g"(t) is the flow of public services the representative agent enjoys in its underground operations without exposing and compromising its underground nature. This relates to the total flow of public services as $\gamma G(t)$, where γ is the share of official public services accessible to the firm when it is operating underground.

K(t) is once again the total stock of capital in the economy (official and underground). β stands for the contribution of public goods and services to underground output as a share of total capital, like α with regard to official output in equation (5).

Large production plants are easier to detect than small ones. Official operations have full access to capital markets, while underground operations do not. These aspects constrain the firms when choosing the technology to be adopted for their underground operations. Therefore, it makes sense to assume that official production relies more heavily on capital, i.e. that it is more capital intensive, than underground production. The latter do so to prevent detection and due to the lack of financial resources. Therefore, $1-\beta<1-\alpha \Rightarrow \beta>\alpha$.

The production functions are assumed to satisfy the Inada conditions:

(i) $\lim_{k(t)\to\infty} \frac{dy^o(t)}{dk(t)}=0$, $\lim_{k(t)\to\infty} \frac{dy^u(t)}{dk(t)}=0$, $\lim_{\frac{g(t)}{K(t)}\to\infty} \frac{dy^o(t)}{d\frac{g(t)}{K(t)}}=0$ and $\lim_{\frac{g(t)}{K(t)}\to\infty} \frac{dy^u(t)}{d\frac{g(t)}{K(t)}}=0$

(ii) $\lim_{k(t)\to 0} \frac{dy^o(t)}{dk(t)}=\infty$, $\lim_{k(t)\to 0} \frac{dy^u(t)}{dk(t)}=\infty$, $\lim_{\frac{g(t)}{K(t)}\to 0} \frac{dy^o(t)}{d\frac{g(t)}{Y(t)}}=\infty$ and $\lim_{\frac{g(t)}{K(t)}\to 0} \frac{dy^u(t)}{d\frac{g(t)}{Y(t)}}=\infty$

Assumption (i) states that the marginal product of an input approaches zero when the amount of that input approaches infinity and assumption (ii) states that the marginal product approaches infinity when the amount of that input approaches zero. These assumptions are sufficient to guarantee that for all finite amounts of inputs used, the marginal products are positive and diminishing, i.e. well-behaved.

The following assumptions are also made regarding the production functions:

(iii) $y^o(t)$ and $y^u(t)$ are finite and non-negative, i.e. the production functions are well-defined functions of the inputs.

(iv) $y^o\big|_{k(t)=\frac{g(t)}{K(t)}=0} = y^u\big|_{k(t)=\frac{g(t)}{K(t)}=0} = 0$, i.e. there is no output without inputs.

(v) $y^o(t)$ and $y^u(t)$ are twice-continuously differentiable and monotonic, i.e. an increase in inputs does not decrease output.

The official and underground stock of capital evolve as follows:

(7) $\dot{k}^o(t)=i^o(t)-\delta k^o(t)$

(8) $\dot{k}^u(t)=i^u(t)-\delta k^u(t)$

where $k^o(t)$ is the quantity of official capital endowments, i.e. the quantity of capital employed by the representative firm in its official operations. Likewise, $k^u(t)$ is the quantity of underground capital endowments, i.e. the quantity of capital used by the representative firm in its underground operations. Finally, $i^o(t)$represents the gross investment in the official sector by the representative firm and $i^u(t)$ represents its grosss investment in the underground sector. δ is the depreciation rate of official and underground capital. Capital for official production enjoys broader access to capital markets, which allows the use of more sophisticated technology. Usually, sophisticated technology gets obsolete faster, which suggests a higher depreciation rate. Nonetheless, and for the sake of simplification, the depreciation rate is assumed to be the same for official and underground capital.

Fiscal authority (Government)

The authorities conduct public policies that enhance welfare. For that purpose, the government provides public goods and services, financing them by levying taxes and by borrowing. Assuming a proportional tax on output, the provision of public goods and services can be derived as follows from the government budget constraint:

$$\begin{aligned} &\dot{B}(t) = G(t) + rB(t) - T(t) \\ (9) \quad &\Leftrightarrow G(t) = T(t) - rB(t) + \dot{B}(t) = \tau Y^o(t) - rB(t) + \dot{B}(t) \end{aligned}$$

In equation (9) G(t) represents the supply of public goods and services, T(t) the tax proceeds and B(t) the stock of public debt. The term rB(t) represents, therefore, the interest burden on the existing stock of public debt. $\dot{B}(t)$ refers to the increment or new issuance of public debt, which is used either to finance the supply of public goods and services or the interest burden on the outstanding debt.

If the government runs a balanced budget, i.e. $\dot{B}(t) = 0$, and there is no outstanding debt, i.e. $B(t) = 0$, equation (9) reduces to:

(10) $\quad G(t) = \tau\, Y^{o}(t)$

To simplify, the supply of public goods and services is assumed equal to the demand of public goods and services.

3.2.1. Decentralized equilibrium

The decentralized equilibrium is determined in this section. The decentralized equilibrium is characterized here as follows:

Definition 1

The decentralized equilibrium is a set of infinite sequences for the quantities $\{c(t),\ i^{o}(t),\ i^{u}(t)\}$ *such that the household maximizes its lifetime utility given by equation (1), subject to its budget constraint given by equation (2), and that the firm maximizes its profits given by equation (3) subject to the capital accumulation dynamics given by equations (7) and (8), for given values of the tax rate,* τ*, the loss of income when operating underground,* λ*, and the total flow of public services,* $G(t)$ *, and given the technology as defined in equations (5) and (6).*

Given that there is free mobility between the sectors, the official and underground rates of return must be the same in the equilibrium. This condition determines in fact the relative size of the underground sector in equilibrium.

3.2.1.1. Optimal control conditions for the decentralized economy

First, the optimization problem for the representative household is solved, proceeding next with the optimization problem of the representative firm. The results are presented below, while the proofs are reported in Appendix 3.A.

Optimization problem for the representative household

The problem of the representative household is to maximize its utility by choosing c(t) subject to the individual intertemporal budget constraint.

$$\underset{\{c\}}{\mathrm{Max}}\ U = \int_0^{\infty} U(c(t))e^{-\rho t}dt$$

s.t. $\dot{a}(t) = (1-\tau)y^{o}(t) + (1-\lambda)y^{u}(t) + ra(t) - c(t)$

Solving this problem yields the following dynamical system:

(11) $$\dot{c}(t) = -\left[\frac{(\rho - r)}{\theta}\right]c(t)$$

(12) $$\dot{a}(t) = (1-\tau)y^{o}(t) + (1-\lambda)y^{u}(t) + ra(t) - c(t)$$

Optimization problem of the representative firm

The problem of the representative firm is to maximize its profits by choosing i(t) subject to the capital accumulation dynamics.

$$\underset{\{i^{o},i^{u}\}}{\mathrm{Max}} \int_0^{\infty}\left[(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha} + (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{1-\beta} - i^{o}(t) - i^{u}(t)\right]e^{-rt}dt$$

s.t. $\dot{k}^{o}(t) = i^{o}(t) - \delta k^{o}(t)$

$\dot{k}^{u}(t) = i^{u}(t) - \delta k^{u}(t)$

where the output prices are normalized to 1. Since the agents do not distinguish the goods and services produced underground from those produced in the official economy, both have prices equal to 1. Further on, the profits are discounted using the market interest rate.

Solving this problem yields the following dynamical system:

(13) $\dot{k}^{o}(t) = i^{o}(t) - \delta k^{o}(t)$

(14) $\dot{k}^{u}(t) = i^{u}(t) - \delta k^{u}(t)$

In the steady-state equilibrium $\dot{c}(t)=0$, $\dot{a}(t)=0$, $\dot{k}^{o}(t)=0$ and $\dot{k}^{u}(t)=0$.

As proven in Appendix 3.A., in the steady-state equilibrium the net marginal product of capital is the same in the official sector and in the underground sector, and equals the sum of the interest rate and the depreciation rate:

(15) $$(3.A.20) \Rightarrow \underbrace{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{-\alpha}}_{\substack{\text{marginal product of capital} \\ \text{in the official sector}}} = r + \delta$$

(16) $$(3.A.20) \Rightarrow \underbrace{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{-\beta}}_{\substack{\text{marginal product of capital} \\ \text{in the underground sector}}} = r + \delta$$

As a matter of fact, this is the only way for the economy to be in equilibrium. If these were different, there would be an incentive to shift production from one sector into the other, either way, depending on which had a larger marginal product of capital.

The relative size of the underground economy (RSU_t) in the decentralized equilibrium is derived in Appendix 3.A yielding:

$$(17) \qquad RSU_t = \frac{y^u(t)}{y^o(t)} = \frac{B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right)\left[\frac{(1-\lambda)(1-\beta)}{r+\delta}\right]^{\frac{1-\beta}{\beta}}}{A^{\frac{1}{\alpha}}\left(\frac{G(t)}{K(t)}\right)\left[\frac{(1-\tau)(1-\alpha)}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}}}$$

This outcome is further discussed in the next sub-section.

3.2.1.2. Macroeconomic equilibrium

The dynamic general equilibrium equations for this economy are obtained by applying the market clearing condition from equation (18), which says that aggregate demand equals aggregate supply, and the aggregate conditions (19) and (20), to the decentralized equilibrium conditions as derived in the previous sub-section. Individual quantities are denoted by lower case letters, while aggregate quantities by the corresponding upper case letters, so that X = Nx. N is the number of agents in the economy.

$$(18) \qquad Y(t) = C(t) + I(t) + G(t)$$

$$(19) \qquad Y(t) = Y^o(t) + Y^u(t)$$

$$(20) \qquad K(t) = K^o(t) + K^u(t)$$

The outcome is as follows:

$$(21) \qquad \dot{C}(t) = -\left[\frac{(\rho - r)}{\theta}\right]C(t)$$

$$(22) \qquad \dot{K}^o(t) = I^o(t) - \delta K^o(t)$$

$$(23) \qquad \dot{K}^u(t) = I^u(t) - \delta K^u(t)$$

$$(24) \qquad Y(t) = Y^{o}(t) + Y^{u}(t) = (1-\tau)A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(K^{o}(t)\right)^{1-\alpha} + (1-\lambda)B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta}$$

and of course the equations (18) and (20).

This yields for the relative size of the underground economy (RSU_t) in the general equilibrium of the decentralized economy:

(25)

$$RSU_t = \frac{Y^{u}(t)}{Y^{o}(t)} = \frac{B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right)\left[\frac{(1-\lambda)(1-\beta)}{r+\delta}\right]^{\frac{1-\beta}{\beta}}}{A^{\frac{1}{\alpha}}\left(\frac{G(t)}{K(t)}\right)\left[\frac{(1-\tau)(1-\alpha)}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}}} = \overbrace{(1-\lambda)^{\frac{1-\beta}{\beta}}}^{F1} * \overbrace{\frac{1}{(1-\tau)}^{\frac{1-\alpha}{\alpha}}}^{F2} * \overbrace{B^{\frac{1}{\beta}}}^{F3} * \overbrace{\frac{1}{\Lambda}^{\frac{1}{\alpha}}}^{F4} * \overbrace{\gamma}^{F5} * \overbrace{\frac{[1-\beta]^{\frac{1-\beta}{\beta}}}{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}}^{F6} * \overbrace{[r+\delta]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}}^{F7}$$

Since the underground economy is different from zero in the decentralized equilibrium, this expression does not tend to zero which implies the existence of a natural level of the underground economy. In the expression above each factor is denoted by F1 to F7. The economic rationale behind the impact of each factor on the relative size of the underground economy is discussed below.

In the decentralized equilibrium the net marginal product of capital is the same in the official sector and in the underground sector. From factors F1 $\left((1-\lambda)^{\frac{1-\beta}{\beta}}\right)$ and F2 $\left(\frac{1}{(1-\tau)}^{\frac{1-\alpha}{\alpha}}\right)$ it may, therefore, be inferred that the tax burden and the income losses when operating underground may be decisive in determining the relative size of the natural level of the underground economy.

Factor F1 tells that larger income losses, when operating underground, lower the relative size of the natural level of the underground economy. This is obvious, because it would make no sense for the agents to operate underground, combining less productive technologies with larger income losses. The opposite applies to the tax burden as shown in Factor F2; larger tax burdens cause the natural level of the underground economy to be relatively larger.

Factors F3 $\left(B^{\frac{1}{\beta}}\right)$, F4 $\left(\frac{1}{A}^{\frac{1}{\alpha}}\right)$ and F6 $\left(\frac{[1-\beta]^{\frac{1-\beta}{\beta}}}{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}\right)$ tell that the restrictions the agents face when designing their production technology to operate underground makes underground operations less attractive. This makes sense because any restriction that imposes a decision different from the one when operating in the official economy affects the potential income generated. The natural level of the underground economy is relatively smaller the more intense these restrictions are. This occurs especially with large differences between the productivity parameters A and B, and large differences between the contribution of capital to production, $(1-\alpha)$ and $(1-\beta)$, respectively.

Factor F5 (γ) tells that the natural level of the underground economy is relatively smaller, i.e. the official sector is relatively larger, the more severe the access of the agents to public goods and services is affected when operating underground. γ measures the share of public goods and services that is accessible to the agent when it is operating in the underground sector. The natural level of the underground economy is relatively smaller, the smaller γ. A smaller γ means that the agent has less access to public goods and services when he is operating underground.

As noted earlier, in the decentralized equilibrium the net marginal product of capital is the same in the official sector and in the underground sector, and equals the sum of the interest rate and the depreciation rate. Therefore, factor F7 $\left([r+\delta]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}\right)$ tells that the natural level of the underground economy is relatively smaller, the larger the marginal productivity of capital. Since official operations are more capital intensive, a higher productivity makes official operations more attractive, hence underground operations less attractive.

So, all variables exert the expected effect on the relative size of the natural level of the underground economy.

3.2.2. Centralized economy

In this section the centralized equilibrium is determined. In this case, the authorities operate as a central planner. The centralized equilibrium is characterized here as follows:

Definition 2

A centralized equilibrium is a set of infinite sequences for the quantities $\{C, K^o, K^u\}$ *such that it maximizes social welfare subject to the macroeconomic intertemporal budget constraint, the capital accumulation equations, and the aggregate resource constraint of the economy, and the path* $\{C, K^o, K^u\}$ *satisfies these constraints, for given values of the tax rate,* τ*, the loss of income when operating underground,* λ*, and the total flow of public services,* G*, and for the given technology.*

Next, the centralized equilibrium in the economy is determined. For this purpose, the general equilibrium that results from the authorities (central planner) maximizing social welfare is determined. The results are presented below, while the proofs are reported in Appendix 3.B.

Centralized equilibrium

The central planner determines the centralized equilibrium by maximizing the social well-being of all agents in the economy. The central planner knows that $G(t)=\tau Y^o(t)$, therefore the central planner solves the following problem:

$$\underset{\{C(t)\}}{\mathrm{Max}}\ U=\int_0^\infty U(C(t))e^{-\rho t}dt$$

$$\text{s.t. } \dot{K}^o(t)=(1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}K^o(t)-C(t)-\delta K^o(t)$$

$$\dot{K}^u(t)=(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(K^o(t)\right)^\beta\left(K^u(t)\right)^{1-\beta}-\delta K^u(t)$$

Solving this problem yields the following dynamical system:

(26) $$\dot{C}(t)=-\frac{1}{\theta}\left[\rho+\delta-(1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]C(t)+\frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta-1}\right]v_2C(t)^{\theta+1}$$

(27) $$\dot{K}^o(t)=(1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}K^o(t)\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}-C(t)-\delta K^o(t)$$

(28) $$\dot{K}^u(t)=(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(K^o(t)\right)^\beta\left(K^u(t)\right)^{1-\beta}-\delta K^u(t)$$

(29) $$\dot{v}_2=\left[\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^\beta\right]v_2$$

As proven in Appendix 3.B. in the equilibrium:

$$(30) \qquad \overline{K}^{u} = \left[\frac{(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}}{\delta} \right]^{\frac{1}{\beta}} * \overline{K}^{o}$$

From equation (30) it may be inferred that necessarily $\overline{K}^{u} \neq 0$; else it would require $\overline{K}^{o} = 0$, which would imply that there is no economy at all. Since this scenario makes economically no sense, it is ignored. There would neither be an underground sector if λ=1, i.e. if the underground agent keeps no income from underground activity. Hence, the centralized equilibrium implies theoretically a positive size of the underground economy, i.e. the underground economy may exist even when there is a central planner who optimizes social welfare. This means that a centralized economy and underground activities are not mutually exclusive.

This outcome is related to the homogeinity of the agents. In this model the agents may operate simultaneously in both sectors, the official and the underground economy. Operating underground deprives the agent only partially the access to public goods and services.

The central planner needs a broad tax base, to generate enough resources to finance the provision of public goods and services. As the agents may operate simultaneously in both sectors, underground operations do not fully deprive the authorities of tax proceeds from the agents operating underground.

This might induce the authorities to tolerate underground activities, despite their efforts to eradicate the underground economy, or at least reduce its size.

The distribution of output among the two sectors in the centralized equilibrium (RSU_t^C) is derived in Appendix 3.B and renders the following result:

$$(31) \qquad RSU_t^C = \overbrace{\left(\frac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}}^{F1} * \overbrace{(1-\lambda)^{\frac{1-\beta}{\beta}}}^{F2} * \overbrace{B^{\frac{1}{\beta}}}^{F3} * \overbrace{\hat{\gamma}}^{F4} * \overbrace{\hat{\tau}}^{F5} * \overbrace{\frac{1}{\overline{K}}}^{F6}$$

Each factor in equation (31) is denoted by F1 to F6. The economic rationale behind the impact of each factor on the relative size of the underground economy in the centralized equilibrium is discussed below.

δ stands for the depreciation rate of official and underground capital. Official operations are assumed to be more capital intensive. Factor F1 $\left(\left(\frac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}\right)$ tells that a higher depreciation rate of capital does not favour underground operations. A high depreciation may be related to more sophisticated technology that gets obsolete faster. These are more expensive, but also more productive. The costs of operating underground, in terms of foregone benefits, are then higher, which makes it less attractive to operate underground.

The income losses when operating underground are represented by λ. Factor F2 $\left((1-\lambda)^{\frac{1-\beta}{\beta}}\right)$ tells that larger income losses related to the underground nature of the operations make underground operations less attractive. The advantages of operating underground disappear if these losses get too high, i.e. if λ approaches 1. In the limit, if λ equals 1, there is no incentive at all to operate underground.

Factor F3 $\left(B^{\frac{1}{\beta}}\right)$ tells that the restrictions the agents face when choosing their production technology to operate underground makes underground operations less attractive. This makes sense, because any restriction that forces a decision different from the one when operating in the official economy affects the potential income. The underground sector is smaller the more intense these restrictions are, i.e. the smaller B. This effect vanishes the larger B gets.

γ measures the share of public goods and services that is accessible to the underground agent. Factor F4 (γ) tells that the underground sector is relatively smaller, the more limited the access of the underground agents to public goods and services.

The tax rate, τ, lies between 0 and 1. So Factor F5 (τ) tells that the higher the tax burden, the more attractive underground activities become. So, if the tax burden is high, official operations are less attractive, and the incentives to operate underground are more pronounced.

Factor F6 $\left(\frac{1}{\overline{K}}\right)$ tells that official production is larger, the larger the stock of capital in the economy. Since official operations are assumed to be more capital intensive, a larger stock of capital in the economy is related to a relatively larger official economy.

So, all variables exert the expected effect on the relative size of the underground economy.

Define ψ as the ratio between this ratio in the centralized equilibrium and this ratio in the decentralized macroeconomic equilibrium. If $\psi > 1$ ($\psi < 1$), then the decentralized equilibrium yields a relative smaller (larger) underground economy. This ratio is derived in Appendix 3.B and renders the following result:

$$\text{(32)} \qquad \psi = \frac{\left.\frac{\overline{Y}^u}{\overline{Y}^o}\right|_C}{\left.\frac{\overline{Y}^u}{\overline{Y}^o}\right|_D} = \underbrace{\overbrace{\left(\frac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}}^{F1}}_{>1} * \underbrace{\overbrace{(\tau)}^{F2}}_{<1} * \underbrace{\overbrace{(1-\tau)^{\frac{1-\alpha}{\alpha}}}^{F3}}_{<1} * \overbrace{\underbrace{A}_{inconclusive}{}^{\frac{1}{\alpha}}}^{F4} * \underbrace{\overbrace{\frac{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}{[1-\beta]^{\frac{1-\beta}{\beta}}}}^{F5}}_{>1} * \underbrace{\overbrace{\left[\frac{1}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}}^{F6}}_{>1} * \underbrace{\overbrace{\frac{1}{\overline{K}}}^{F7}}_{<1}$$

In the expression (32) above each factor is denoted by F1 to F7. The economic rationale behind the impact of each factor is discussed below.

δ in factor F1 $\left(\left(\frac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}\right)$ stands for the depreciation rate. Official operations are assumed to be more capital intensive. Factor F1 tells that higher depreciation rates of capital translate into an underground economy in the centralized equilibrium that is relatively smaller than in the decentralized equilibrium. A high depreciation is usually related to more sophisticated technologies that get obsolete faster. Those technologies are more expensive, but also more productive. Then, the central planner is less inclined to tolerate underground operations since this affects overall welfare.

The lower the tax burden, the less attractive underground activities are. If the tax burden is low, the incentives to operate underground are limited. Moreover, the central planner tolerates less underground activities since it needs a broad tax base, in combination with the low tax rate, to generate enough resources to finance the provision of public goods and services. That may explain why Factors F2 (τ) and F3 $\left((1-\tau)^{\frac{1-\alpha}{\alpha}}\right)$ indicate the central planner tolerates relatively less underground activities compared to the decentralized macroeconomic equilibrium.

Factor F4 $\left(A^{\frac{1}{\alpha}}\right)$ tells that more productive official technologies move the rational individual agents faster away from underground operations compared to the central planner. On the one hand, the individual agent is better equipped, maybe due to its proximity, to better evaluate the technologies. On the other hand, the central planner might want to take other social aspects into consideration.

Agents face restrictions when choosing their production technology to operate underground in order to prevent the detection of those activities. Factor F5 $\left(\frac{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}{[1-\beta]^{\frac{1-\beta}{\beta}}}\right)$ tells that those restrictions make underground operations less attractive. This makes sense, because restrictions force decisions different from an unconstrained scenario. This affects the potential to generate income. The underground sector should be relatively smaller the more intense these restrictions are, forcing major differences between the contribution of capital to production, (1-α) and (1-β), respectively. Factor F5 tells that the cost-benefit analysis performed by a rational individual agent is sharper than the central planner who takes other social aspects into consideration..

Factor F6 $\left(\left[\frac{1}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}\right)$ is pressing the relative size of the official economy in the centralized equilibrium. The larger the sum of the interest rate and the depreciation rate the more difficult it is for investments to be viable. Since official operations are more capital intensive, this may force the acceptance of relatively more underground activities by the central planner

Factor F7 $\left(\frac{1}{\overline{K}}\right)$ tells that the existence of a large stock of capital, leads the central planner to choose for a relatively smaller underground economy, since official operations are more capital intensive. Once the available stock of capital is large, it should be used efficiently. That may explain a relatively larger official economy in the centralized equilibrium, since the central planner knows better the extent of the total stock of capital in the economy. Moreover, due to its more capital intensive nature the existence of a large stock of capital is related to a relatively larger official economy.

3. 3 A neoclassical general equilibrium model with underground activities and heterogeneous agents

Once again, a neoclassical general equilibrium model is constructed, using the framework provided by the endogenous growth literature, to assess the existence of a natural level of the underground economy.

In this two sectors (official and underground) model the economy is characterized as described in Section 3.2, with the following adjustments:

- There are three agents: the official agent, the underground agent, and the fiscal authority.

- The representative official and underground agents maximize their utility subject to a budget constraint.
- The fiscal authority (government) raises taxes and supplies public goods and services.
- There is free mobility across sectors, i.e. at any time an agent may decide to switch to the other sector. But an agent cannot operate simultaneously in both sectors: it belongs either to the official economy or to the underground economy.
- The representative official and underground agents supply an inelastic amount of labour. Since capital includes human and physical capital, labour supply enters the model through (human) capital.
- Official agents pay taxes; underground agents do not pay taxes. But the latter incur an income loss due to the need to undertake measures to keep their activity undetected.
- Official agents have full access to public goods and services, and to capital and insurance markets, while underground agents have limited access.
- The tax revenues collected from the official economy are used to finance the provision of public goods and services.

Representative official agent

The economy is assumed to be populated by equal, infinitely-lived official agents. These agents are endowed with equal starting levels of capital, including human and physical capital. The population is constant and given exogeneously. Each member of society is assumed to be active, either in the official or in the underground economy. The representative official agent chooses consumption to maximize lifetime utility subject to its budget constraint.

Lifetime utility of the representative official agent is given by

$$(33) \qquad U^{o} = \int_{0}^{\infty} u^{o}(c^{o}(t))e^{-\rho t}dt$$

where $c^{o}(t)$ is consumption per capita, and $\rho > 0$ is the constant rate of time preference. The utility function $u^{o}(c^{o}(t))$ has the same functional form and properties as the one introduced in Section 3.2.

It operates the technology presented in equation (5), i.e the same technology the agent described in the model in Section 3.2 uses when he is operating in the official economy:

$$(34) \qquad y^{o}(t) = A\left(\frac{g'(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha} = A\left(\frac{G(t)}{K(t)}\right)^{\alpha} \left(k^{o}(t)\right)^{1-\alpha}, 0 < \alpha < 1 \text{ and } 0 \leq k^{o}(t) \leq 1$$

The properties of this production function have been extensively discussed when introducing equation (5) in Section 3.2.

The budget constraint of the representative official agent determines the change over time in capital assets to be:

$$(35) \qquad \dot{k}^{o}(t) = i^{o}(t) - \delta k^{o}(t) = (1-\tau)y^{o}(t) - c^{o}(t) - \delta k^{o}(t) = (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} \left(k^{o}(t)\right)^{1-\alpha} - c^{o}(t) - \delta k^{o}(t)$$

where $k^{o}(t)$ is the quantity of capital endowments owned by the representative official agent, $i^{o}(t)$ is the gross investment by the representative official agent, δ is the depreciation rate of official capital, $(1-\tau)y^{o}(t)$ represents the net income earned by the representative official agent, which is spent on consumption, $c^{o}(t)$, and capital, $k^{o}(t)$. τ is the tax rate and satisfies the condition $0<\tau<1$.

Representative underground agent

The representative underground agent is assumed infinitely-lived as well. The population of underground agents is constant and given exogeneously. Each underground agent has the same starting levels of capital, including human and physical capital. The representative underground agent chooses consumption to maximize lifetime utility subject to its budget constraint. Lifetime utility is modelled the same way as for the official agent and is given by:

(36) $$U^u = \int_0^\infty u^u(c^u(t))e^{-\rho t}dt$$

where $c^u(t)$ is consumption per capita, and $\rho > 0$ is the constant rate of time preference. The utility function $u^u(c^u(t))$ is assumed to have the same functional form and properties as the one introduced in Section 3.2.

It operates the same technology as the agent in Section 3.2 when operating in the underground economy, as presented in equation (6):

(37) $$y^u(t) = B\left(\frac{g^u(t)}{K(t)}\right)^\beta (k^u(t))^{1-\beta} = B\left(\frac{\gamma G(t)}{K(t)}\right)^\beta (k^u(t))^{1-\beta}, 0 < \gamma < 1 \text{ and } 0 \le k^u(t) \le 1$$

The properties of this production function were discussed in Section 3.2 when equation (6) was introduced.

The budget constraint of the representative underground agent follows the same pattern as the one of the representative official agent and determines the change over time in capital assets to be:

(38) $$\begin{aligned} \dot{k}^u(t) &= i^u(t) - \delta k^u(t) = (1-\lambda)y^u(t) - c^u(t) - \delta k^u(t) \qquad , \quad 0 < \lambda < 1 \\ &= (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^\beta \left(k^u(t)\right)^{1-\beta} - c^u(t) - \delta k^u(t) \end{aligned}$$

where $k^u(t)$ represents the capital endowments of the representative underground agent and $i^u(t)$is its gross investment. The depreciation rate of underground capital is assumed to be the same as the depreciation rate of official capital and is given by δ. The income earned by the underground agent is given by $(1-\lambda)y^u(t)$. He spends his income on consumption, $c^u(t)$, and capital, $k^u(t)$. λ lies between $0<\lambda<1$ and is the income loss incurred by the representative underground agent to keep its operations undetected as discussed in Section 3.2.

Fiscal authority (Government)

The government enters the model the same way as described in equation (10) in Section 3.2.

(39) $G(t) = \tau\, Y^o(t)$

So it is once again assumed that the authorities provide public goods and services and that these expenditures are financed exclusively by levying taxes, i.e. the authorities run a balanced budget. To simplify the supply of public goods and services is once again assumed to equal the demand for public goods and services.

3.3.1. Decentralized equilibrium

The decentralized equilibrium is determined in this section. The decentralized equilibrium is characterized here as follows:

Definition 3

The decentralized equilibrium is a set of infinite sequences for the quantities $\{c^o(t),\ c^u(t),\ k^o(t),\ k^u(t)\}$ *such that the representative official agent maximizes its lifetime utility, given by equation (33), subject to is budget constraint as given by equation (35), and the representative underground agent maximizes its* *lifetime utility, given by equation (36), subject to is budget constraint as given by equation (38), for given values of the tax rate, τ, the losses incurred by the representative underground agent, λ, and the total flow of public services, $G(t)$, and given the technology as defined in equations (34) and (37).*

Given that there is free mobility across sectors, in equilibrium the official and underground rates of return must be the same. This condition determines in fact the relative size of the underground sector in the decentralized equilibrium.

3.3.1.1. Optimal control conditions for the decentralized economy

First, the optimization problem for the representative official agent is solved. Next, the analysis proceeds with the optimization problem of the representative underground agent. The results are presented below, while the proofs are reported in Appendix 3.C.

Optimization problem for the representative official agent

The problem of the representative official agent is to maximize its utility by choosing $c^{o}(t)$ subject to its intertemporal budget constraint (35).

$$\underset{\{c^{o}\}}{\mathrm{Max}}\, U^{o} = \int_{0}^{\infty} u^{o}(c)^{o} e^{-\rho t} dt$$

$$\text{s.t. } \dot{k}^{o}(t) = (1-\tau) A \left(\frac{G(t)}{K(t)} \right)^{\alpha} \left(k^{o}(t) \right)^{1-\alpha} - c^{o}(t) - \delta k^{o}(t)$$

$$0 \le k^{o}(t) \le 1$$

Solving this problem yields the following dynamical system, as proven in Appendix 3.C.:

(40) $$\dot{c}^{o}(t) = -\left[\frac{\rho+\delta-(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{-\alpha}}{\theta}\right]c^{o}(t)$$

(41) $$\dot{k}^{o}(t) = (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{1-\alpha} - c^{o}(t) - \delta k^{o}(t)$$

Optimization problem for the representative underground agent

The problem of the representative underground agent is to maximize its utility by choosing $c^{u}(t)$ subject to its intertemporal budget constraint (38).

$$\underset{\{c^{u}\}}{\mathrm{Max}}\ U^{u} = \int_{0}^{\infty} u^{u}(c)^{u} e^{-\rho t} dt$$

$$\text{s.t. } \dot{k}^{u}(t) = (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^{u}(t)\right)^{1-\beta} - c^{u}(t) - \delta k^{u}(t)$$

$$0 \leq k^{u}(t) \leq 1$$

Solving this problem yields the following dynamical system:

(42) $$\dot{c}^{u}(t) = -\left[\frac{\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^{u}(t)\right)^{-\beta}}{\theta}\right]c^{u}(t)$$

(43) $$\dot{k}^{u}(t) = (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^{u}(t)\right)^{1-\beta} - c^{u}(t) - \delta k^{u}(t)$$

In the steady-state equilibrium $\dot{c}^{o}(t) = 0$, $\dot{k}^{o}(t) = 0$, $\dot{c}^{u}(t) = 0$ and $\dot{k}^{u}(t) = 0$. As proven in Appendix 3.C., in the equilibrium the net marginal product of capital is the same in the official and in the underground sector, and equals the sum of the interest rate and the depreciation rate:

(44)
$$\underbrace{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{-\alpha}}_{\substack{\text{marginal product of capital}\\ \text{in the official sector}}} = r+\delta$$

(45)
$$\underbrace{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{-\beta}}_{\substack{\text{marginal product of capital}\\ \text{in the underground sector}}} = r+\delta$$

This is the only way the economy can be in equilibrium. If these were different, there would be an incentive to switch from one sector into the other, either way, depending on which had a larger marginal product of capital. The model assumes indeed that the agents belong either to the underground economy or to the official economy, i.e. they cannot operate simultaneously in both sectors. But, there is free mobility across the sectors, so any agent can switch any moment from one sector into the other. The incentives to switch vanish only when the marginal products of capital are the same. By solving the optimization problems above, each agent decides to which sector he wants to belong.

The relative size of the underground economy (RSU_t) is derived in Appendix 3.C yielding:

(46)
$$RSU_t = \frac{y^{u}(t)}{y^{o}(t)} = \frac{B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right)\left[\frac{(1-\lambda)(1-\beta)}{\rho+\delta}\right]^{\frac{1-\beta}{\beta}}}{A^{\frac{1}{\alpha}}\left(\frac{G(t)}{K(t)}\right)\left[\frac{(1-\tau)(1-\alpha)}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}}}$$

This is exactly the same result as obtained with the model developed in Section 3.2. This equation was discussed and interpreted in sub-section 3.2.1.

3.3.1.2. Macroeconomic equilibrium

The dynamic general equilibrium equations for this economy are obtained by applying the market clearing condition from equation (47), which says that aggregate demand equals aggregate supply, and the aggregate conditions (48) and (49), to the decentralized equilibrium conditions as derived in the previous sub-section. Individual quantities are denoted by lower case letters, while aggregate quantities by the corresponding upper case letters, so that X = Nx. N is the number of agents in the economy.

(47) $$Y(t) = C(t) + I(t) + G(t)$$

(48) $$Y(t) = Y^{o}(t) + Y^{u}(t)$$

(49) $$K(t) = K^{o}(t) + K^{u}(t)$$

The arbitrage condition (51) also holds:

(50) $$\rho = r + \delta = (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(K^{o}(t)\right)^{-\alpha} + \delta = (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^{u}(t)\right)^{-\beta} + \delta$$

The outcome is as follows:

(51) $$\dot{C}^{o}(t) = -\left[\frac{\rho + \delta - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}}{\theta}\right]C^{o}(t)$$

(52) $$\dot{C}^{u}(t) = -\left[\frac{\rho + \delta - (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^{u}(t)\right)^{-\beta}}{\theta}\right]C^{u}(t)$$

$$\text{(53)} \qquad \dot{K}^{o}(t) = (1-\tau)A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(K^{o}(t)\right)^{1-\alpha} - C^{o}(t) - \delta K^{o}(t)$$

$$\text{(54)} \qquad \dot{K}^{u}(t) = (1-\lambda)B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta} - C^{u}(t) - \delta K^{u}(t)$$

$$\text{(55)} \qquad Y(t) = Y^{o}(t) + Y^{u}(t) = A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(K^{o}(t)\right)^{1-\alpha} + B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta}$$

and of course the equations (47) and (49).

This yields for the relative size of the underground economy (RSU_t) in the general equilibrium of the decentralized economy:

$$RSU_t = \left.\frac{\overline{Y}^{u}}{\overline{Y}^{o}}\right|_{D} = \frac{B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(\overline{K}^{u}\right)^{1-\beta}}{A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(\overline{K}^{o}\right)^{1-\alpha}} = \frac{B^{1/\beta} * \left(\frac{\gamma G(t)}{\overline{K}}\right) * \left(\frac{(1-\beta)(1-\lambda)}{\rho+\delta}\right)^{\frac{1-\beta}{\beta}}}{A^{1/\alpha} * \left(\frac{G(t)}{\overline{K}}\right) * \left(\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right)^{\frac{1-\alpha}{\alpha}}} = \frac{B^{1/\beta} * \gamma * \left(\frac{(1-\beta)(1-\lambda)}{\rho+\delta}\right)^{\frac{1-\beta}{\beta}}}{A^{1/\alpha} * \left(\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right)^{\frac{1-\alpha}{\alpha}}} =$$

$$= \overbrace{(1-\lambda)^{\frac{1-\beta}{\beta}}}^{F1} * \overbrace{\frac{1}{(1-\tau)}^{\frac{1-\alpha}{\alpha}}}^{F2} * \overbrace{B^{\frac{1}{\beta}}}^{F3} * \overbrace{\frac{1}{A}^{\frac{1}{\alpha}}}^{F4} * \overbrace{\gamma}^{F5} * \overbrace{\frac{[1-\beta]^{\frac{1-\beta}{\beta}}}{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}}^{F6} * \overbrace{\left(\frac{1}{\rho+\delta}\right)^{\frac{1-\beta}{\beta}-\frac{1-\alpha}{\alpha}}}^{F7}$$

This is the same result as obtained with the model developed in Section 3.2. In the expression above each factor is denoted by F1 to F7. The economic rationale behind the impact of each factor on the relative size of the underground economy was discussed in sub-section 3.2.1.2.

So both models reach the same outcome concerning the existence and size of the natural level of the underground economy. This outcome is related to the features of the models designed in Sections 3.2 and 3.3.

The model in Section 3.2 assumes homogeneous agents, i.e. the agents may operate simultaneously in the official sector and in the underground sector. The model in Section 3.3 assumes heterogeneous agents, i.e. the agents operate either in the official sector or in the underground sector.

But both models allow free mobility between the official and the underground sector. So, the heterogeneity of the agents in the model in Section 3.3 limits their individual choices, i.e. their mobility. Since the remaining structure of the models is essentially the same, this generates on aggregate the same resources devoted to underground operations. This explains why both models yield the same outcome concerning the existence and the size of the natural level of the underground economy.

3.3.2. Centralized economy

In this section the centralized equilibrium is determined. In this case, the authorities operate as a central planner. The centralized equilibrium is characterized here as follows:

Definition 4

A centralized equilibrium is a set of infinite sequences for the quantities $\{C^o, C^u, K^o, K^u\}$ *such that it maximizes social welfare subject to the macroeconomic intertemporal budget constraint, the capital accumulation equations, and the aggregate resource constraint of the economy, and the path* $\{C^o, C^u, K^o, K^u\}$ *satisfies these constraints for given values of the tax rate,* τ*, the loss of income when operating underground,* λ*, and the total flow of public services,* $G(t)$*, and for the given the technology.*

In the equilibrium $\dot{C}^o(t)=0$, $\dot{C}^u(t)=0$, $\dot{K}^o(t)=0$ and $\dot{K}^u(t)=0$. As proven in Appendix 3.D. in the centralized equilibrium $\overline{C}^u=0$ and $\overline{K}^u=0$.

Since no inputs are devoted to underground activities in the centralized equilibrium, there is no underground activity in a centralized economy. This means that the central planner tolerates no underground activity. This outcome is related to the heterogeneity of the representative agents. Here the agents do not operate simultaneously in both sectors. An agent that operates underground is deprived to the full extent of γ of access to public goods and services. This moves agents away from the underground economy.

In addition, the central planner tolerates no underground activity due to the need to secure a broad tax base to finance the provision of public goods and services. An agent that operates underground pays no taxes at all. That leads the authorities to fully eradicate underground activities in the centralized equilibrium.

Consequently, the relative size of the underground economy (RSU_c), given by the ratio of underground production and official production, in the centralized equilibrium relative to the decentralized equilibrium equals zero. This outcome implies that the economy is fully official.

Define ψ as the ratio between this ratio in the centralized equilibrium and in the decentralized macroeconomic equilibrium. If $\psi > 1$ ($\psi < 1$), then the decentralized equilibrium yields a relative smaller (larger) underground economy.

$$\psi = \frac{\left.\frac{\overline{Y}^u}{\overline{Y}^o}\right|_C}{\left.\frac{\overline{Y}^u}{\overline{Y}^o}\right|_D} = \frac{0}{\frac{(1-\lambda)^{\frac{1-\beta}{\beta}}}{(1-\tau)^{\frac{1-\alpha}{\alpha}}} * \frac{B^{\frac{1}{\beta}}}{A^{\frac{1}{\alpha}}} * \gamma * \frac{(1-\beta)^{\frac{1-\beta}{\beta}}}{(1-\alpha)^{\frac{1-\alpha}{\alpha}}} * (\rho+\delta)^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}} = 0$$

This outcome tells that there is no underground economy in the centralized equilibrium, i.e. the central planner forces the size of the natural level of the underground economy downwards to zero. The economic rationale behind this outcome is discussed next.

In this model, contrary to the model in Section 3.2, the agents do not operate simultaneously in both sectors. They operate either officially or underground. In this model, operating underground deprives the agents to the full extent of γ of the public goods and services, while in the previous model this was limited to the extent the agent operates underground. This coexists with technological restrictions when operating underground. So once the central planner internalizes the advantages and disadvantages of operating officially he is even more inclined to favour official operations compared to the previous model.

Moreover, the central planner needs a broad tax base to generate enough resources to finance the provision of public goods and services. Since agents operating underground pay no taxes at all in this model, the central planner is less willing to tolerate underground activities.

This induces the central planner to disapprove any underground activity. The actions of the central planner seem to be directed towards the total eradication of the underground economy. Therefore, it may be concluded that the central planner seems to perceive that the costs of underground activities exceed their 'benefits'. Finally, while the underground sector in the market equilibrium may signal social norms in each country, this does not seem to influence the attitude of the authorities towards underground activities in this model.

3. 4 Conclusions

The first model constructed in Section 3.2 assumes free mobility between the official and underground economy and assumes homogenous agents that may operate simultaneously in the official economy and in the underground economy. The second model in Section 3.3 still assumes free mobility between the official and underground economies, but the agents are heterogenous and cannot operate simultaneously in the official and underground economy. In the second model an agent belongs either to the official economy or to the underground economy.

Due to the free mobility assumption, both models require, in the decentralized equilibrium, the equivalence of the net marginal product of capital in the official and in the underground economy. This is the only way the economy can be in equilibrium. If the marginal product of capital were different, there would be an incentive to switch from one economy into the other, either way, depending on which had a larger marginal product of capital.

Both models suggest the existence of an underground economy in the decentralized equilibrium. This confirms the initial hypothesis of the existence of a natural level of the underground economy, which has been operationalized by the size of the underground economy in the decentralized equilirium. This makes sense because taxes will always be levied in order to finance the provision of public goods and services and regulations are needed to prevent excesses. Since both aspects are empirircally found to cause underground economic activities, the existence of a natural level of underground economic activity seems logic.

The two models predict the same size of the natural level of the underground economy. This outcome is related to the assumption of free mobility between the official and the underground economies in both models. The heterogeneity of the agents in the model in Section 3.3 generates individual choices different from those in the model in Section 3.2, but the similarity of the two models concerning the remaining structure, especially the free mobility, delivers that on aggregate the same resources are devoted to underground economic operations. This explains why both models do not only predict the existence of a natural level of the underground economy, but also predict the same size of the natural level of the underground economy.

The models do however not reach the same result in the centralized equilibrium. Contrary to the model with homogenous agents, no underground activity is tolerated by the authorities in the centralized equilibrium in the model with heterogenous agents. This is explained by the heterogeinity of the agents in the second model: the agents do not operate simultaneously in both economies; they either operate officially or underground. In the first model, the agents are deprived from public goods and services to the extent that they operate underground. But in the second model, the access of agents operating underground to public goods and services is restricted up to the full extent of γ. This adversity is reinforced with technological restrictions when operating underground. So once the central planner internalizes the advantages and disadvantages of operating official he is more inclined to favour official economic operations compared to the first model.

In addition, the central planner tolerates less underground activities since it needs a broad tax base to generate enough resources to finance the provision of public goods and services. As the agents in the second model do not operate simultaneously in both sectors, an agent that operates underground does not pay any taxes. This explains why the authorities in the second model are less inclined to tolerate underground economic activities and do not allow for the existence of any underground economic activity. The actions of the authorities, in the second model, seem to target the total eradication of the underground economy. Therefore, it may be concluded that the authorities seem to perceive that the costs of underground activities exceed its 'benefits'.

Chapter 4. The natural level of the underground economy: simulations

4. 1 Introduction

In terms of decentralized equilibrium, Chapter 3 introduced two neoclassical general equilibrium models to assess the existence of a natural level of underground economic activity. The level of underground economic activity in the decentralized equilibrium is called the natural level of the underground economy. The first model assumes free mobility between the official and underground economy and considers homogenous agents that may operate simultaneously in the official and underground economy.

The second model also assumes free mobility between the official and underground economies, but the agents are heterogeneous. This means that the agents cannot operate simultaneously in the official and underground economy; they belong either to the official economy or to the underground economy.

Both models suggest the existence of underground economic activity in the decentralized equilibrium. This result confirmed the hypothesis of the existence of a natural level of underground economic activity. This outcome is not surprising, because there will always be taxes in order to finance public policies and regulations in order to prevent excesses. Both aspects are among the main causes for the existence of underground activities, and therefore imply the existence of a natural level of underground economic activity.

The first model developed in Chapter 3 is calibrated in this chapter. This model is chosen because it better resembles the real world. Homogeneity means that the agents may operate simultaneously in both sectors, official and underground. It is more common that, in addition to official operations, agents operate underground, rather than agents operating exclusively underground.

Next, the calibration process of the model is described and simulations are performed. The simulations serve to assess the adherence of the model. The calibrated model also supports empirically the existence of a natural level of underground economic activity. This exercise is performed for some developed[10] and some developing[11] countries. The data used for this purpose is described in Appendix 4.A. The data is reported in the Appendices 4.B to 4.K. The final section contains concluding remarks and observations.

4. 2 Model calibration and simulations

In this section, the model is calibrated for each aggregate of countries, namely developed countries and developing countries. In the model, the official economy is given by $Y^{o}(t)=A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(K^{o}(t)\right)^{1-\alpha}$ and the underground economy is given by $Y^{u}(t)=B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta}$. The model is calibrated to reproduce the relative size of the underground economy for each aggregate of countries.

To calibrate the model, it was first econometrically estimated to get an idea of the size of the parameters. This was done separately for each group of countries and also separately

[10] The countries considered in the sample are: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

[11] The countries considered in the sample are: Algeria, Argentina, Bangladesh, Bolivia, Brazil, Cameroon, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Iran, Israel, Jamaica, Jordan, Kenya, Madagascar, Malaysia, Mexico, Morocco, Nicaragua, Pakistan, Panama, Paraguay, Peru, Philippines, Singapore, South Africa, Tunisia and Turkey.

for the official economy and the underground economy, respectively. For this purpose, the logarithm of the equations describing the official economy and the underground economy is taken, yielding for the official economy and for the underground economy the following results, respectively:

$$\ln Y^{o}(t) = \mu_1 + \mu_2 \ln G(t) + \mu_3 \ln \overline{K}(t)$$

where $\mu_1 = \ln A + (1-\alpha)\ln\psi_o$, $\psi_o = \dfrac{K^{o}(t)}{\overline{K}(t)}$ and

$\mu_2 = \alpha$

$\mu_3 = (1-2\alpha)$

$$\ln Y^{u}(t) = \upsilon_1 + \upsilon_2 \ln G(t) + \upsilon_3 \ln \overline{K}(t)$$

where $\upsilon_1 = \ln B + \beta \ln \gamma + (1-\beta)\ln\psi_u$, $\psi_u = \dfrac{K^{u}(t)}{\overline{K}(t)}$

$\upsilon_2 = \beta$

$\upsilon_3 = (1-2\beta)$

The proofs are reported in Appendix 4.L.

The estimates that result from the estimation of these equations are used as starting point to calibrate the model. The parameters are calibrated to best reproduce the official economy and the underground economy for each aggregate of countries. The outcome of this exercise is presented and discussed in the next sub-sections.

4.2.1. Calibration and simulations: developed countries

Schneider and Buehn (2009) report point estimates for the underground economy in developed countries for the years 1996, 1998, 2000, 2002, 2003, 2004, 2005 and 2006. The data is pooled and the parameters are estimated by means of pooled regression. The estimation results are reported in Appendix 4.M.

Next, the parameters are calibrated to reproduce the size of the official and the underground sector with the smallest deviations possible. The baseline parameter values for the developed countries are reported in Table 2.

Table 2. Baseline parameters developed countries

	Official economy		Underground economy		
	A	α	B	β	γ
Developed countries	0.65	0.0355	0.60	0.0450	0.8

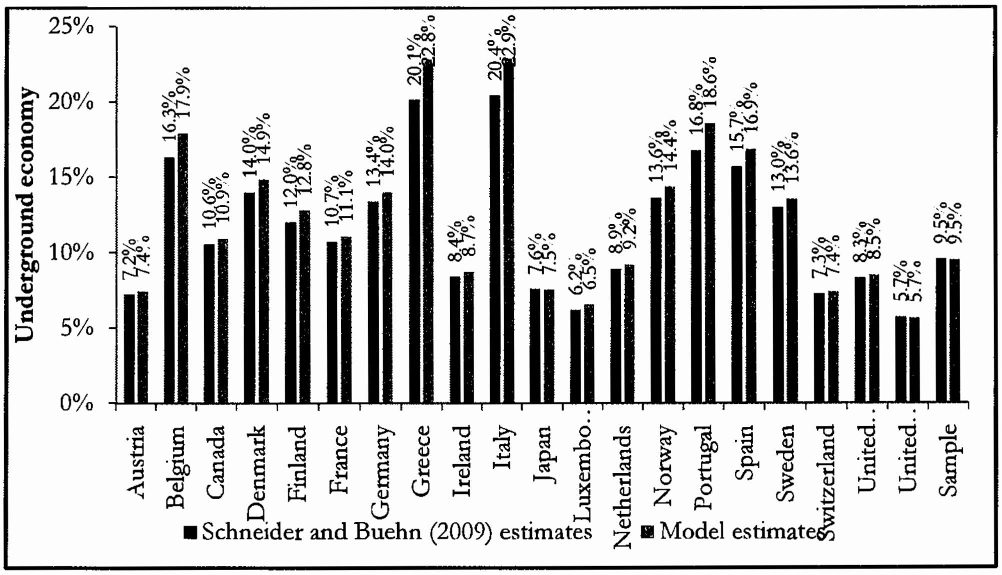
The relative size of the parameters in Table 2 corresponds to the discussion in Chapter 3. For instance, as expected the productivity parameter is larger in the official economy than in the underground economy (A>B). This means that underground production is less productive than official production. This follows from the constraints the agents face when designing the production processes for the underground production, i.e. when choosing the production technology in an effort to prevent their activity from being detected by the authorities. It is obvious that this constraint affects the productivy relative to the productivy in the official economy.

The dependency of production in each sector on public goods and services as inputs is also as predicted in Chapter 3, i.e. $\alpha < \beta$ holds. This means that the underground economy depends more on public goods and services as inputs than the official economy does. The latter relies more on its own resources rather than public goods and services that facilitate official production and are secondary as direct production factors.

The adherence of the model is checked by estimating the size of the underground economy for each individual country and comparing these estimates with the values as measured by Schneider and Buehn (2009). Figure 1 reports the underground estimates by Schneider and Buehn (2009) and the estimates produced by the model.

Figure 1 shows that the model is able to reproduce the estimates by Schneider and Buehn (2009) for the underground economy individually quite well. It is also able to reproduce its aggregate size.

Figure 1. Underground economy: Estimates by Schneider and Buehn (2009) versus model estimates



For simulation purposes, the interest rate is set equal to the market interest rate for government bonds[12]: 0.055. In addition, starting with a depreciation rate of 0.07 for the US economy, like Easterly and Rebelo (1993), and adjusting it next for the differential in the share of residential buildings in the total fixed capital, especially with respect to the European Union, this figure reduces to 0.062.

It is assumed that underground agents have access to 80% of the public goods and services provided (γ=0.8). It is further assumed that firms incur a loss of income of approximately 6.8% when operating underground (λ=0.068). These parameters are

[1212] Source: www.tradingeconomics.com.

arbitrarily set at these levels such that the relative size of the underground economy, as predicted by the model, best proxies the relative size of the underground economy for each country, as measured by Schneider and Buehn (2009), and its aggregate size for the sample as well.

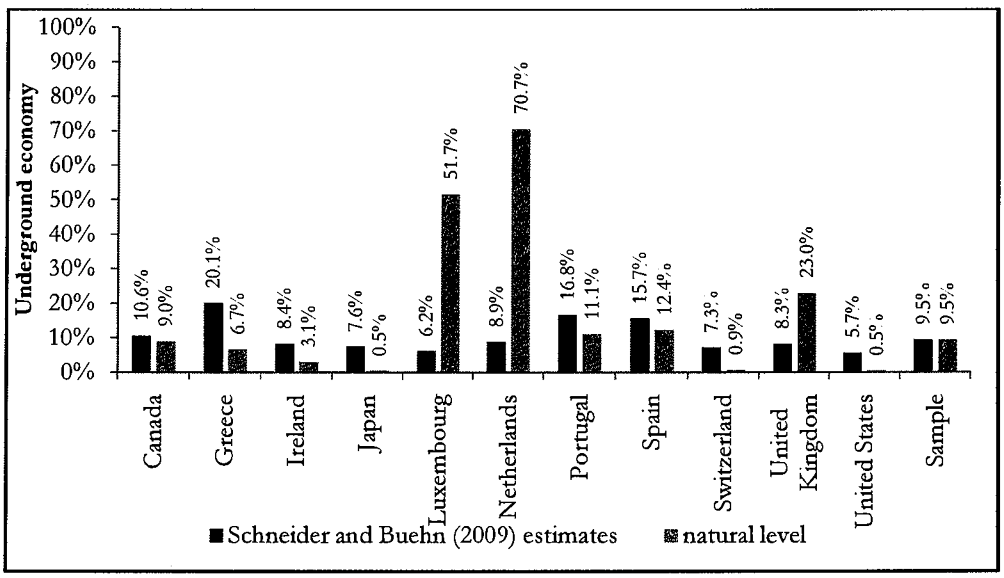
Based on these calibrations the model yields a natural level of underground economic activity close to 9.5% in the steady-state equilibrium for the sample of developed countries. The estimates for each country are graphed in Figure 2. As shown, some countries are operating above their steady-state equilibrium, while others are operating below their steady-state equilibrium. This captures the idea that individually the economies may not be operating at their steady-state, but that on aggregate the outcome is levelled to the steady-state equilibrium.

The probability that the economy is operating above its natural level of underground economic activity is assessed in Appendix 4.N. The analysis is performed for partial simulations with the access to public goods and services when producing underground (γ) and the loss of income when operating underground (λ), respectively.

The results reported in Appendix 4.N. suggest that some developed economies are most likely operating with an underground sector that is larger than induced by structural features. The simulations suggest that in some cases, like in Canada, Greece, Ireland, Japan, Portugal, Spain, Sweden, Switzerland and the United States, the underground economies definitely exceed the respective natural levels. This result is related to the influence of τ in explaining the size of the underground economy in this model. The countries mentioned earlier have relatively low tax burdens. As noted in Chapter 2, the tax burden is among the main causes for the existence of underground acivities. In this model, it is the main cause. Their relatively lower tax burdens cause the natural levels of underground activity to be relatively lower compared to other developed countries. This explains the higher probability that these countries operate above their respective natural levels of underground activity.

Lower natural levels of underground economic activity, as a consequence of lower tax burdens, makes the need to restrict the use of public goods and services by agents operating underground and the need to penalize underground activities less urgent in these countries.

Figure 2. Underground economy: Estimates by Schneider and Buehn (2009) versus the natural level



No estimate for the size of the natural level of the underground economy in Austria, Belgium, Denmark, Finland, France, Germany, Italy, Norway and Sweden is provided. The tax burden in these countries is that high that the model produces estimates of 100%.

As noted earlier, the tax burden is the main variable causing underground economic activities in this model. This model yields for high tax regimes, starting from approximately 40.4%, estimates for the relative size of the natural level of the underground economy of 100%.

Hence, this model is able to generate estimates for the natural level of the underground economy for tax burdens that range from 0% up to 40.4%. The model predicts that the natural level of the underground economy equals 0%, if the tax burden is 0%. Up to tax burdens of 29.3%, the natural level of the underground economy does not exceed 1%. Starting from tax burdens of 40.4%, the natural level of the underground economy equals 100%. This pattern is also visible in Figure 5.

Next, simulations are performed using different values for the key parameters in this model that affect the size of the underground production: the access to public goods and services when producing underground (γ), the loss of income when operating underground (λ), and the tax ratio (τ).

Figure 3 and Figure 4 capture the sensibility of the size of the natural level of underground economic activity when γ and λ change, respectively. Figure 3 tells that there is a positive linear relationship between the natural level of underground economic activity and the access underground agents enjoy to public goods and services in this model. This means that unrestricted access to public goods and services coincides with larger natural levels of the underground economy. The blue dot in Figure 3 represents the current position of the aggregate developed countries in the sample, assuming 80% access to public goods and services by agents operating underground. From among the variables in the model, this one seems to be the one requiring relatively more efforts to achieve small reductions of the size of the natural level of the underground economy.

The access agents operating underground enjoy to public goods and services is indicative of the efforts the authorities effectively undertake to prevent them from using public goods and services. Greater efforts restrict the access to public goods and services by agents operating underground. The access to public goods and services by agents operating underground also captures the quality and functioning of public institutions. Better performing public institutions help prevent that the use of public goods and services by underground agents goes undetected, hence restricting the access to public goods and services by agents operating underground.

Figure 3. Natural level of the underground economy for different values of γ

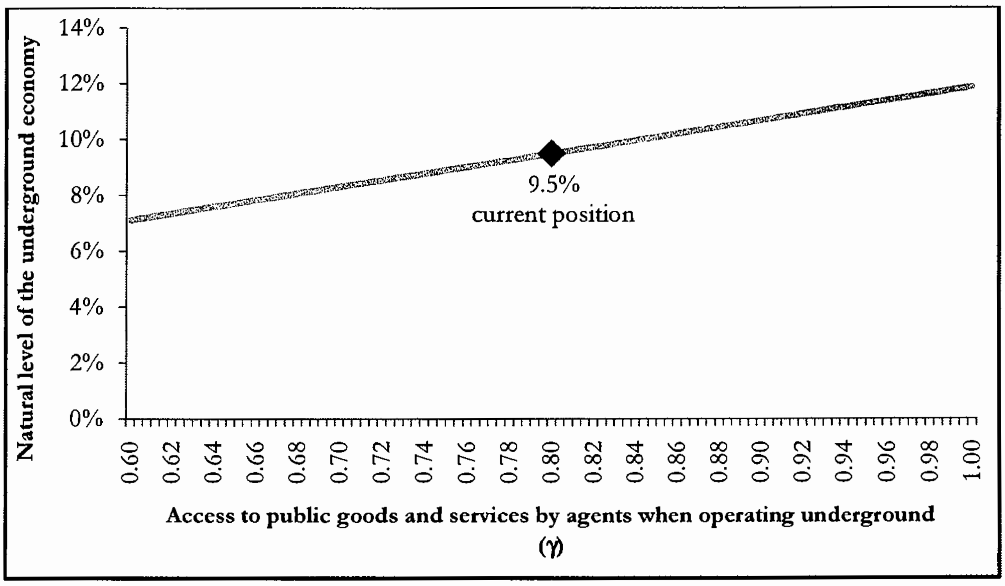
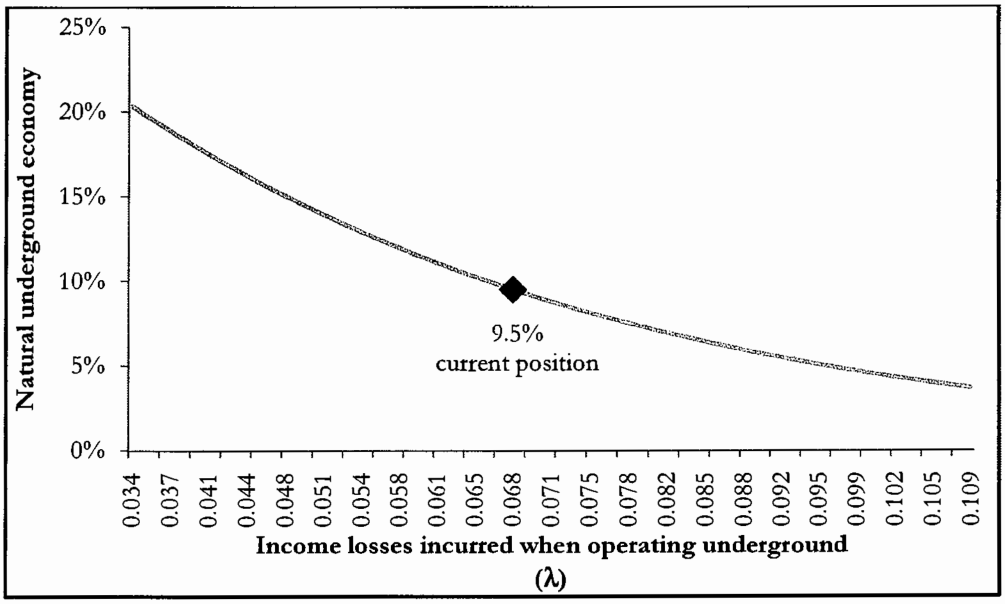


Figure 4 shows that there is a negative relationship in this model between the natural level of the underground economy and the income losses incurred by the agents when operating underground. This variable captures the quality and functioning of public institutions and the degree of enforcement of regulations and controls. Both aspects strongly determine the extent to which agents operating underground incur income losses due to their underground nature.

From Figure 4, it might be inferred that there is still some scope to reduce the size of the natural level of the underground economy by hurting the income agents earn when operating underground. But its size appears to be decreasingly responsive to changes of λ. The blue dot in Figure 4 represents the aggregate position of the aggregate developed countries in the sample, assuming income losses incurred by the agents when operating underground of 6.8%. Small changes seem to require considerable efforts to squeeze the income earned underground.

Figure 4. Natural level of the underground economy for different values of λ



In addition, the results of the analysis of the responsiveness of the size of the natural level of the underground economy to changes of the tax ratio are reported in Figure 5, while keeping all other variables unchanged. It seems to suggest that considerable tax cuts are needed to reduce the size of the natural level of the underground economy. On the other hand, it seems to suggest that relatively small tax increases would cause the natural level of the underground economy to expand strongly. The blue dot in Figure 5 represents the current aggregate position of the developed countries in the sample, given by a tax-to-output-ratio of 35%.

Figure 5. Natural level of the underground economy for different values of τ

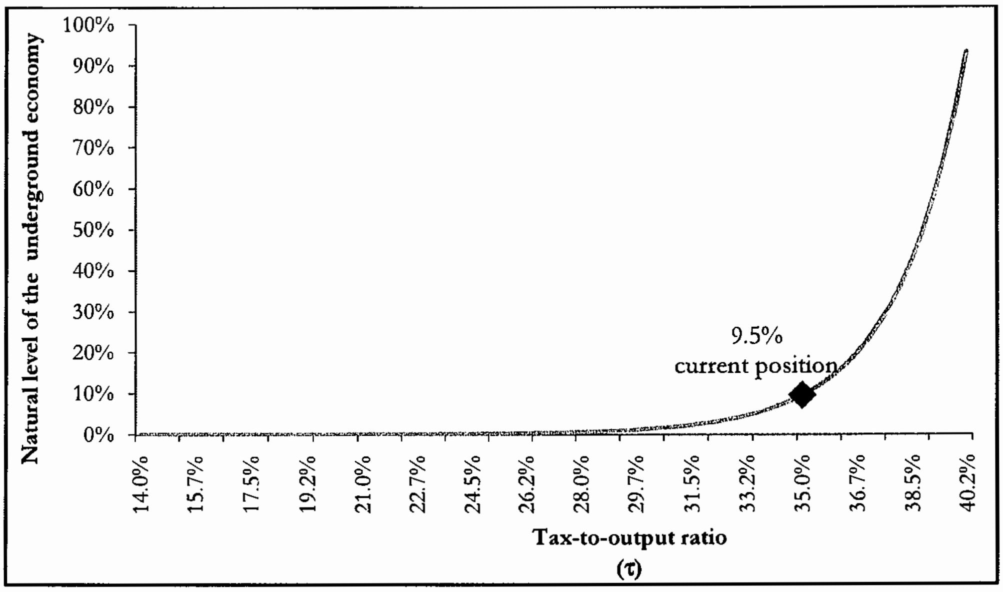
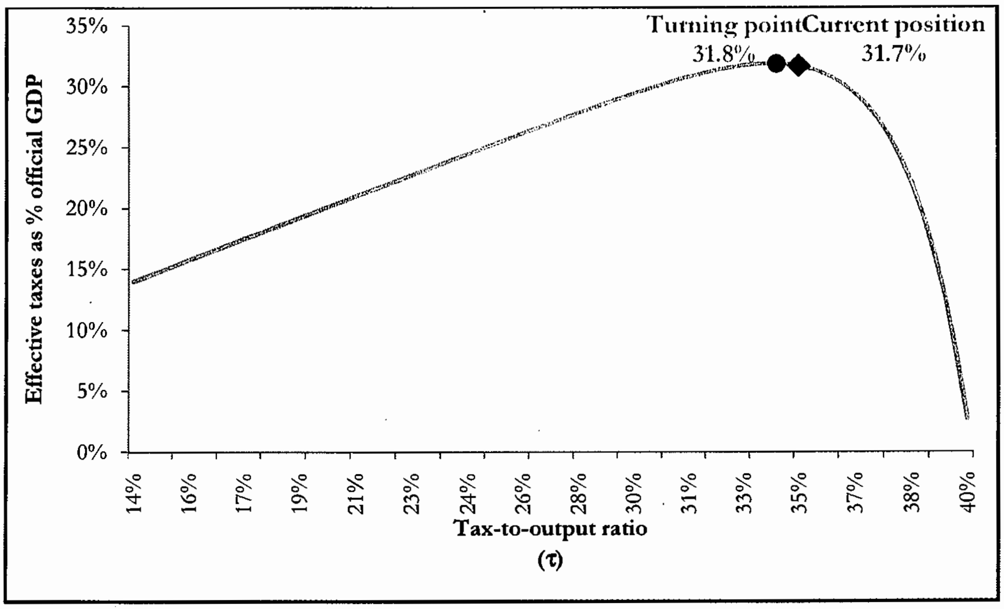


Figure 6 presents the relation between the tax burden and the effective tax revenues as a percentage of the official GDP. Apparently, the authorities in the developed world are on aggregate fully exploiting all scope to levy taxes. Departing from the current tax position, further tax increases would significantly erode the tax base. However, on aggregate the authorities seem to be operating slightly passed the point where tax revenues are maximized.

Figure 6 shows that cutting taxes to 34.3% down from 35.0% would reduce the size of the natural level of the underground economy and contribute to raise more taxes, i.e. 31.8% up from 31.7%, despite the lower tax burden. Changing the tax burden, changes the size of the underground economy. This effect on the tax base is accounted for by adjusting the tax proceeds with the estimated impact on the size of the underground economy. The ordinate pair (34.3%, 31.8%) represents the turning point: up to this point tax increases yield higher tax proceeds and from there on tax proceeds start declining if taxes are further increased. Figure 6 presents evidence of what used to be called the Laffer curve. This result is obtained by considering the interaction between the tax burden and underground economic activities.

Figure 6. Tax burden and effective tax revenues as a percentage of official GDP



The aggregate position passed the turning point as shown in Figure 6 might be related to the lack of exact knowledge regarding the structure of the economy or regarding the position of the economy relative to underground activities. Nonetheless, the deviation seems pretty small.

Figures 5 and 6 suggest that there is limited scope to reduce the size of the natural level of the underground economy through tax cuts without loosing considerable tax proceeds. Cutting taxes and subsequently reducing the size of the natural level of the underground economy also demands more resources to provide full access to public goods and services to the agents that have turned official.

4.2.2. Calibration and simulations: developing countries

Schneider and Buehn (2009) report point estimates for the size of the underground economy in developing countries for the years 1999, 2000, 2001, 2002, 2003, 2004, 2005 and 2006. The data is pooled and the parameters are estimated by means of pooled regression. The estimation results are reported in Appendix 4.M.

Next, the parameters are calibrated to reproduce the size of the official and the underground sector with the smallest deviations possible. The baseline parameter values for the developing countries are are given in Table 3.

Table 3. Baseline parameters developing countries

	Official economy		Underground economy		
	A	α	B	β	γ
Developing countries	0.6	0.0215	0.5125	0.0363	0.9

Like the model for the developed world, the relative size of the parameters in Table 3 also corresponds to the discussion in Chapter 3. The productivity parameter is larger in the official economy (A>B). This means that underground production is less productive than official production and follows from the constraints the agents face when designing the production processes for the underground production.

The dependency of production in each sector on public goods and services as inputs is also as predicted in Chapter 3, i.e. $\alpha < \beta$ holds. This means that the underground sector depends more on public goods and services as inputs than the official sector does.

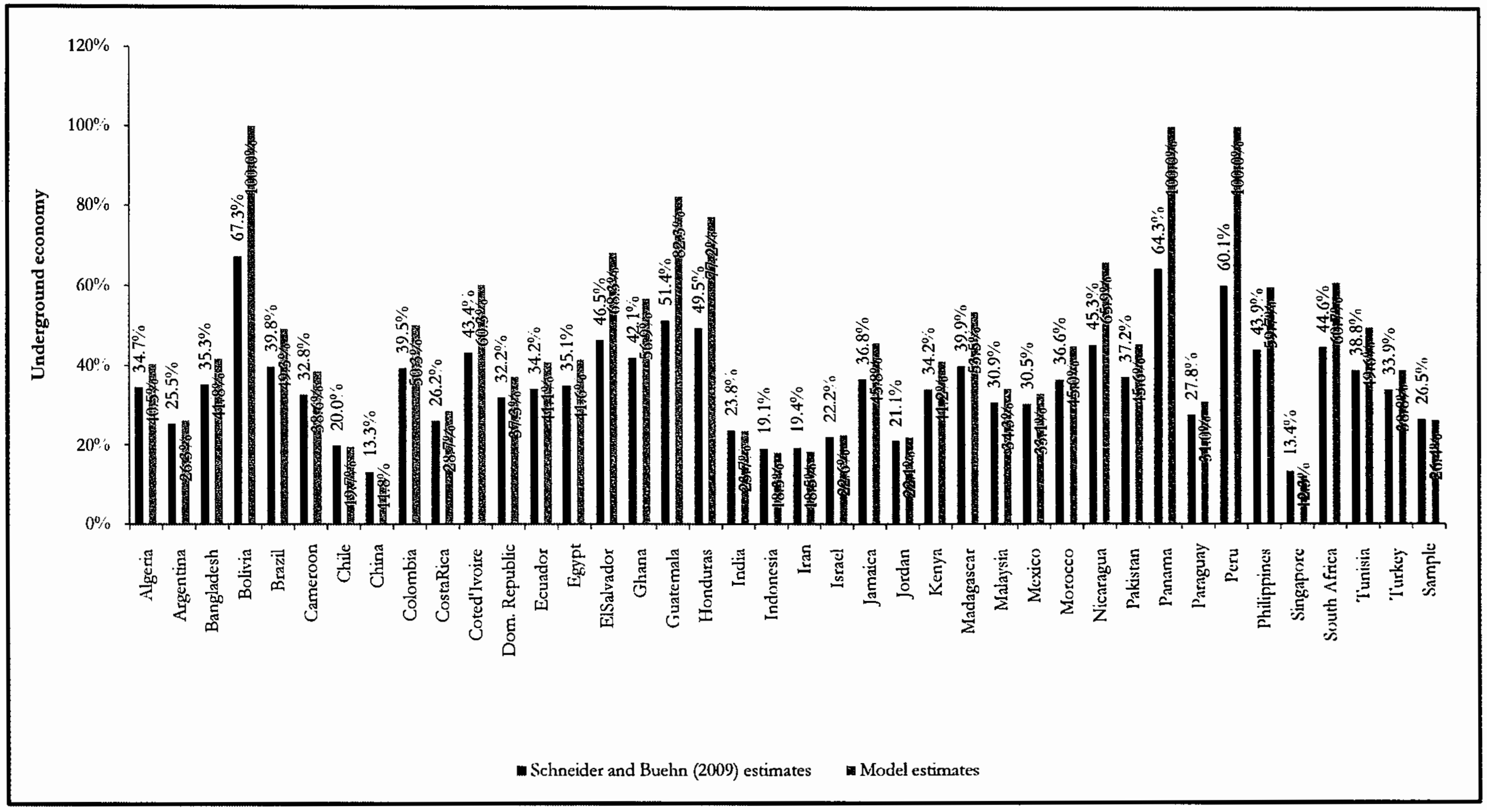
The adherence of the model for the developing countries in the sample is checked by estimating the size of the underground economy for each country and comparing the estimates with the values as measured by Schneider and Buehn (2009). Figure 7 reports the underground economy estimates by Schneider and Buehn (2009) and the estimates produced by the model. This exercise shows that in general the model predicts a larger size of the underground economy than the values measured by Schneider and Buehn (2009).

For simulation purposes, the interest rate is set equal to the market interest rate for Brazilian government bonds[13]: 0.155. A depreciation rate of 0.21 is assumed, which is an average for the countries studied in Bu (2004). The depreciation rate of the stock of capital in the developing world is higher than the one observed for the developed world. Bu (2004) found that the depreciation rate of the stock of capital is commonly larger in some developing countries. It may result from inappropriate maintenance and usage of the capital due to the lack of resources and properly trained staff. It may also be a consequence of distortions caused by government financing policies that lead to premature discard.

It is assumed that underground agents have access to 90% of the public goods and services provided (γ=0.9). It is further assumed that firms incur a loss of income of approximately 2.5% when operating underground (λ=0.025). These parameters are set at

[13] Source: www.tradingeconomics.com.

Figure 7. Underground economy: estimates by Schneider and Buehn (2009) versus model estimates



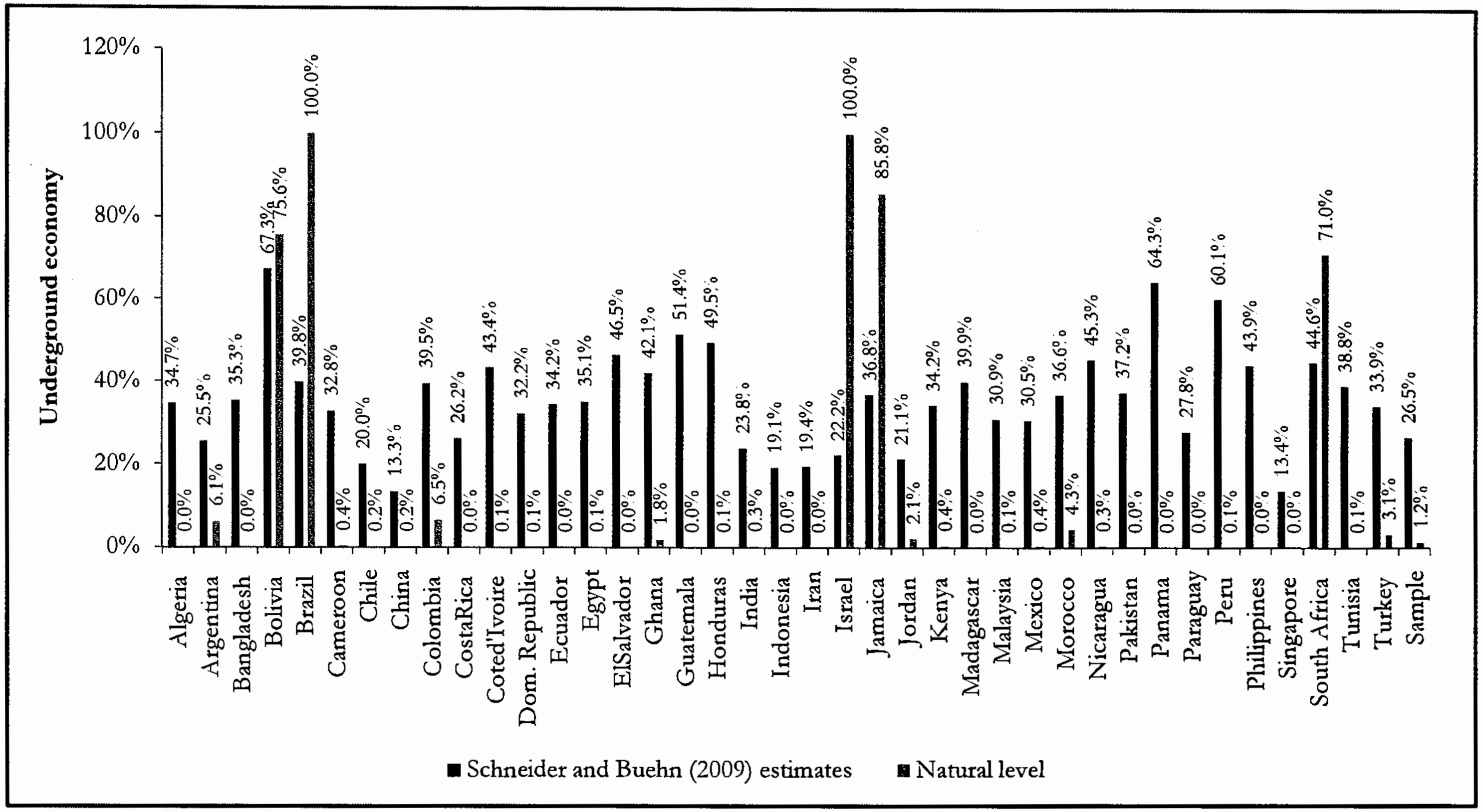
these levels such that the relative size of the underground economy, as predicted by the model, best proxies the relative size of the underground economy for each country, as measured by Schneider and Buehn (2009).

Figure 8 shows that the model predicts extremely low natural levels of underground economic activity for the developing countries. Using the parameters calibrated as summarized above yields for the aggregate of the developing countries in the sample a natural level of the underground economy that tends to 1.2% in the steady-state equilibrium. This is lower than the sample average.

This outcome is related to the influence of the tax burden in explaining the underground economy in this model. The tax burden in the developing world is lower than in the developed world. This may attribute a smaller explanatory role to the tax burden in determining the size of the (natural level of the) underground economy in the developing countries compared to the developed world and cause the model to underestimate its (natural) size.

This model is able to generate estimates for the natural level of the underground economy for tax burdens that range from 0% up to 27.4%. The model predicts that the natural level of the underground economy equals 0%, if the tax burden is 0%. Up to tax burdens of 19.8%, the natural level of the underground economy does not exceed 1%. Starting from tax burdens of 27.4%, the natural level of the underground economy equals 100%. This pattern is also visible in Figure 11.

Figure 8. Underground economy: Estimates by Schneider and Buehn versus the natural level



Countries with low levels of natural underground economic activity also exhibit lower than average tax burdens. In the developing world, the other explanatory variables, like the social norms, the regulatory framework and the quantity and quality of public goods and services may be more important when deciding whether to operate underground or not. The other variables in the model do not seem capable to control for these extreme results. This means that the model exhibits difficulties in dealing with very high and very low tax burdens.

The probability that the economy is operating above its natural level of underground economic activity is assessed in Appendix 4.O. The analysis is performed for partial simulations with the access to public goods and services when producing underground (γ) and the loss of income when operating underground (λ), respectively.

The results reported in Appendix 4.O suggest that the economies are most likely operating with an underground sector that is larger than induced by the structural features captured by the model. The simulations suggest that, except for Bolivia, Brazil, Israel, Jamaica and South Africa, the underground economies are operating beyond their natural levels.

This result is related to the influence of τ in explaining the size of the underground economy in this model. The countries mentioned have a relatively higher tax rate. As noted in Chapter 2, the tax burden is among the main causes for the existence of underground acivities. In this model, it is the main cause. Their relatively higher tax burdens cause the natural levels of underground economic activity to be relatively higher compared to other developing countries. This explains why the probability that these countries operate above their respective natural levels of underground economic activity is smaller. The lower tax burden in the other countries generates lower natural levels of the underground economy.

Next, simulations are performed using different values for the key parameters in this model that affect the size of the underground economy: the access to public goods and services when producing underground (γ), the loss of income when operating underground (λ) and the tax ratio (τ).

Figure 9 and Figure 10 capture the sensibility of the size of the natural level of underground economic activity when γ and λ change, respectively. Figure 11 tells once again that there is a positive linear relationship in this model between the natural level of underground economic activity and the access agents enjoy to public goods and services when operating underground.

Figure 9. Natural level of the underground economy for different values of γ

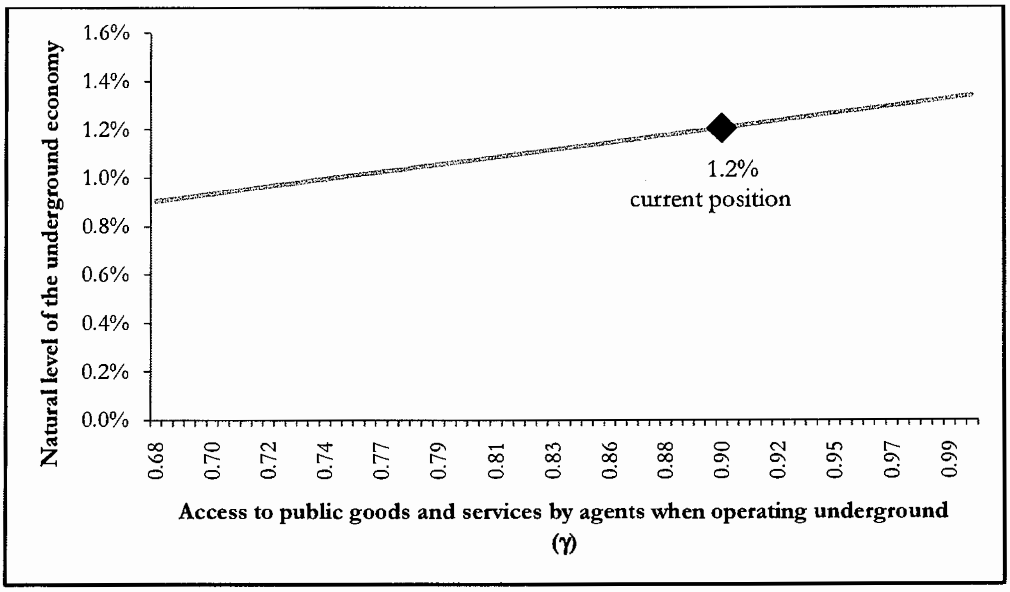
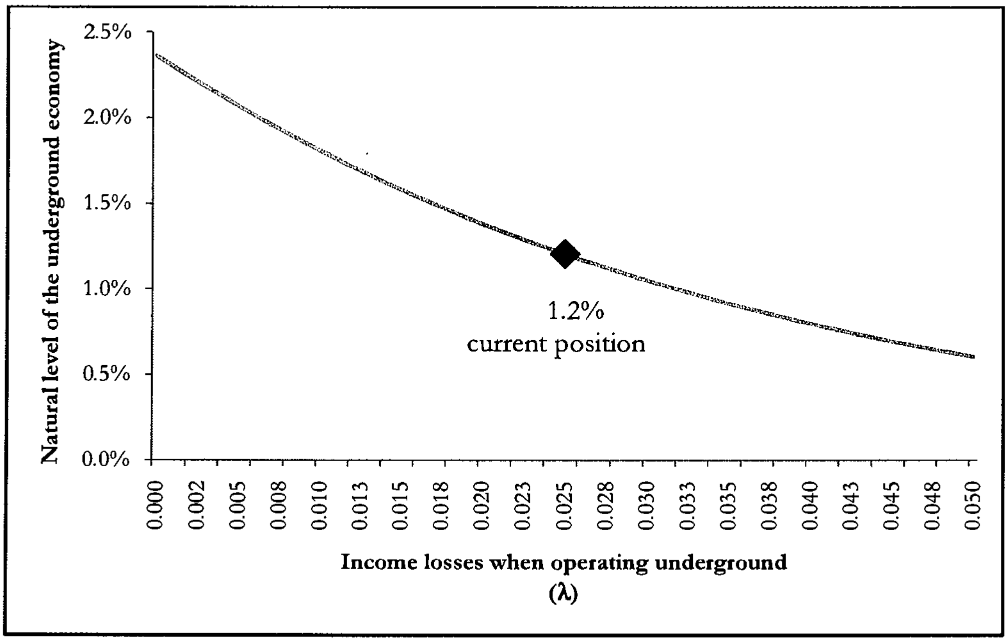


Figure 10 shows there is a negative relationship between the natural level of the underground economy and the income losses incurred by the agents when operating underground. It might be inferred from Figure 10 that there is still some scope to reduce the size of the natural level of the underground economy by hurting the income agents earn when operating underground. But the size of the natural level of the underground economy seems to be decreasingly responsive to changes of λ.

Figure 10. Natural level of the underground economy for different values of



Considerable efforts to limit the access of agents to public goods and services when operating underground or squeeze the income earned underground seem necessary to achieve minor reductions of the natural level of underground economic activity.

Figure 11. Natural level of the underground economy for different values of τ

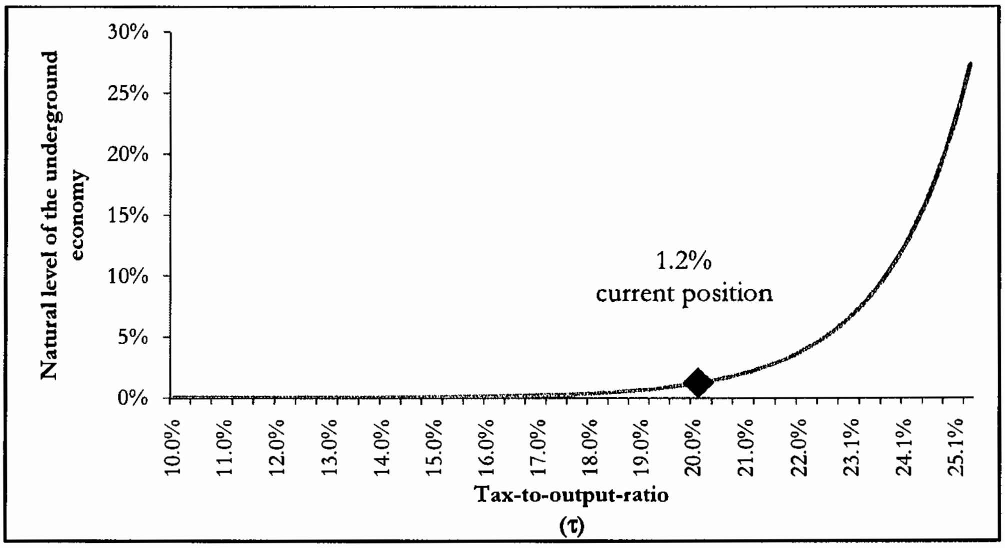
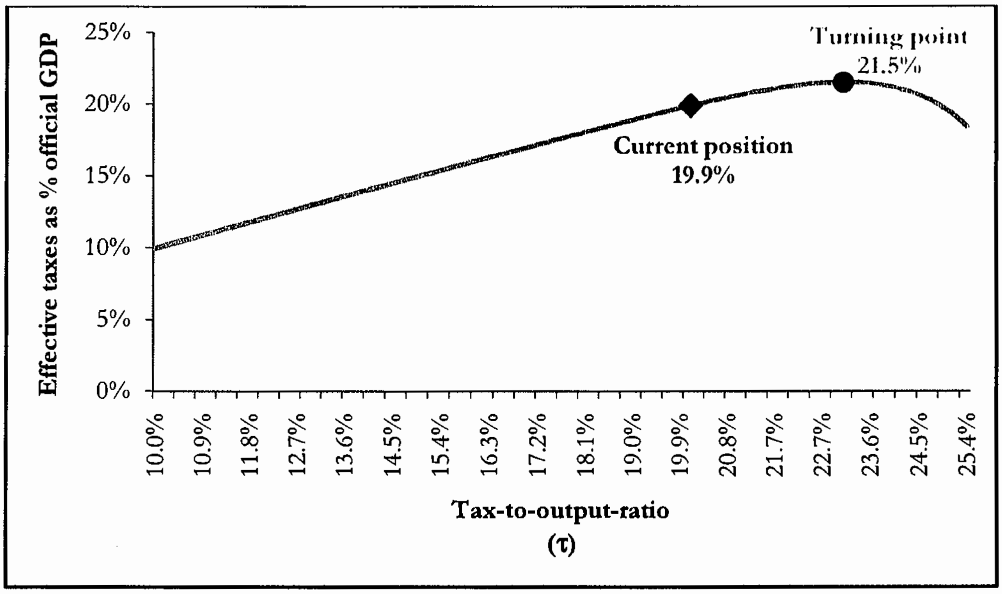


Figure 11 reports how the natural level of the underground economy responds to changes of the tax-burden, while keeping all other variables unchanged. It seems to suggest that large tax cuts are required to significantly reduce the size of the natural level of the underground economy. On the other hand, it seems to suggest that relatively small tax increases would cause its size to expand strongly.

Figure 12 presents the relation between the tax burden and the effective tax revenues as a percentage of the official GDP. Apparently, the authorities in the developing world are not fully exploiting the scope to levy taxes. The authorities do not seem to have reached the point where tax revenues are maximized. Figure 12 shows that raising the tax rate to 23.1% up from 20.1% generates more taxes despite it increasing the size of the natural level of the underground economy.

Figure 12. Tax burden and effective tax revenues as a percentage of official GDP



The ordinate pair (23.1%, 21.5%) represents the turning point: up to this point tax increases yield higher tax proceeds and from there on tax proceeds start declining if taxes are further increased. Figure 12 presents evidence of what used to be called the Laffer curve. This result is obtained by accounting for the interaction between the tax burden and underground economic activities.

Figures 11 and 12 suggest that there is scope to increase taxes. The aggregate position below the turning point, as shown in Figure 12, might be related to the lack of exact knowledge regarding the structure of the economy or regarding the position of the economy relative to the natural level of the underground economy.

4. 3 Conclusions

The first model developed in Chapter 3 is calibrated in this chapter. This model is chosen because it better resembles the real world by considering homogeneous agents, i.e. agents that may operate simultaneously in the official and underground economy, in contrast to heterogeneous agents. This model is able to reproduce the figures for the underground economy in the developed world quite well, individually and on aggregate as well. Concerning the developing world, it seems to suggest that the size of the underground economy is larger than the size measured by Schneider and Buehn (2009).

The relative size of the parameters within each aggregate of countries corresponds to the discussion in Chapter 3. The productivity parameter in the official economy is as expected larger than in the underground economy. The developed world uses more productive, i.e. more advanced, technology than the developing world. This holds for official production and underground production as well. This means that both, official and underground production, are less productive in the developing world compared to the developed world. This makes sense since here capital is assumed to include human capital as well. More developed countries have more educated and better educated human resources, which translates into higher productivities.

In addition, the underground production in the developed world seems to be as productive as the official production in the developing world. So the restrictions that developing countries face to access or implement more productive, i.e. more advanced, technology are apparently stronger than the restrictions faced by agents in the developed world when selecting the underground production technology to prevent detection. This makes sense since the nature of the underground activities in the developed world is different from the developing world. The former may constitute a way to improve the standards of living by taking advantage of the loopholes in the legal and regulatory systems. The latter is mainly a way of subsistence.

The economic structure may also play a role in determining the productivity in the official economy and in the underground economy. The economy in the developed world is more knowledge and services based. In fact, no production plants are needed to perform the related economic activities underground. For instance, many of these activities just require a computer and an internet connection. Some of these activities may be performed at home and go easily undetected. Or they may easily be classified as a hobby. Under such circumstances, the productivity of the agents is not severely affected when they operate underground, because the constraints when choosing the production technology to operate underground are less severe.

In contrast, the economy in the developing world comprises relatively more manufacturing. Smaller or artesanal production plants are needed to perform the related economic activities underground. These plants are more difficult to keep undetected. This means that the productivity of the agents is more severely affected when they operate underground.

There are, of course, also similarities. For instance, the handy man enjoys more or less the same flexibility and faces more or less the same constraints, in developed and developing countries, when deciding which activities he performs officially and which activities he performs underground.

Underground production relies relatively more on public goods and services as inputs. Official production relies more heavily on its own resources; the main purpose of public goods and services is to support official production and not to serve as direct production factors. Hence, the dependency of production in each sector on public goods and services as inputs is also as discussed in Chapter 3.

The same relations hold for developed and developing countries. But official production in the developing world relies more on public goods and services as inputs compared to underground production in the developed world. This may be related to economic and sociological characteristics of the developing world that enhance the dependency on public goods and services in those countries.

It is assumed that the access to public goods and services by the agents operating underground in the developed world is more restricted compared to the developing world, namely 80% compared to 90%. This makes sense since the authorities in the developing countries lack the resources, due to larger underground sectors, to enforce regulations and to set up qualitatively functioning public institutions. This makes it more difficult to restrict the access to public goods and services by agents when engaging in underground activities. This grants agents in the developing world, engaged in underground activities, broader access to public goods and services, without exposing their underground nature.

The model exhibits some difficulties in estimating the natural level of underground economic activity, if the tax burden is extremely high. The model is able to produce estimates for the natural level of the underground economy in developed countries for tax burdens that range from 0% up to 40.4% and for tax burdens that range from 0% up to 27.4% in developing countries. The model predicts that the natural level of the underground economy equals 0%, if the tax burden is 0% and, that starting from tax burdens of 40.4% and 27.4% the natural level of the underground economy equals 100% in developed countries and in developing countries, respectively. The natural level of the underground economy does not exceed 1% in developed countries and in developing countries for tax burdens up to 29.3% and 19.8%, respectively. This outcome is related to the strong explanatory role of the tax burden in this model.

Some developed countries with the smallest underground sectors have high tax burdens. Following the logic that taxes drive agents into underground economic operations, as established in this model, this should, ceteris paribus, produce larger natural levels of underground economic activities within this model. On the other hand, this allows them to provide a broad range of public goods and services and to set up qualitatively functioning public institutions that enforce compliance. This makes it more attractive for the agents to operate in the official economy and also more difficult to operate underground. This aspect is not sufficiently captured by the model when the tax burden is relatively high. This applies also to developing countries with relatively high tax burdens.

On the other hand, the model predicts low levels of natural underground activity in developing countries with relatively low tax burdens. But developing countries with large underground sectors usually have low tax burdens. Following, once again, the logic that low tax burdens make it attractive to operate official, as established in this model, this should, ceteris paribus, produce smaller natural levels of underground economic activity within this model. But low tax burdens also constrain the authorities in the provision of public goods and services and in the set up of qualitatively functioning public institutions that should enforce compliance. This makes it more attractive and easier to operate in the underground economy. This aspect is not sufficiently captured by the model when the tax burden is relatively low.

The other variables in the model are only partially able to control for these extreme results. This exposes some limitations of the model, which does, however, not compromise its use for the purposes of this study. The model and its projections have been used taking these limitations into account. These limitations can be dealt with by extending the model, i.e. by including additional relevant explanatory variables as discussed in Chapter 2.

Especially, a stronger explanatory role of the quality of the public goods and services could improve the performance of the model. This aspect is only partially captured in the model by the access agents operating underground enjoy to public goods and services[14]. In countries with very high tax burdens, the model predicts that the natural underground economy absorbs the whole economy. But in these countries, high tax burdens usually go hand in hand with improved quality of public goods and services. Its coverage is broader and its intrinsic quality is also better. This occurs because the higher tax burden allows the provision of more and qualitatively better public goods and services. The opposite applies to countries with low tax burdens.

In this case, the model could include a composite variable that measures the quality of the public goods and services relative to the tax burden. This may improve the estimate by the model of the size of the natural underground economy, because the higher (lower) tax burden increases (lowers) indeed its size, but the quality of the public goods and services, possible by (due to) higher (lower) tax burdens, lowers (expands) its size.

[14] Because the quality of the public goods and services itself influences the extent to which agents operating underground enjoy access to public goods and services.

Another aspect is that, under special circumstances, high tax burdens may not be perceived as excessive by the agents. As mentioned in Chapter 2, this depends on the extent to which the agents sense they are being reimbursed for the higher tax burden through more and better public goods and services. This might be particularly the case in the developed world, where countries like Sweden, have broad social services and overall highly qualitative public goods and services. This is related to reigning social norms. Social norms governing tax morale are defined as the willingness to pay taxes. Worsening tax morale may lead to increased participation in underground activities.

Tax morale may also depend on the perception of the fairness of the tax system. Tax systems that are perceived as equitable, may strengthen the social norms against tax evasion. But objections against the way taxes are spent, may encourage tax evasion. This may be accounted for through the inclusion of a variable measuring the social norms.

The inclusion of an index measuring the existence of burdensome and costly government regulations may also improve the performance of the model in extreme cases. The inclusion of a corruption index in the model may also relax the relation between the size of the natural underground economy and the tax burden. Buehn and Schneider (2009) present empirical evidence of a positive relationship between the size of the underground economy and corruption. Corruption is closely related to the functioning of the legal system, because a disfunctioning legal system provides fertile grounds for corruption.

This is why it is emphasized that this model is suitable for developed countries, with tax burdens ranging from 0% up to 40.4%, and for developing countries, with tax burdens ranging from 0% up to 27.4%.

Simulations were performed using different values for the key parameters in this model that affect the size of the underground economy: the access to public goods and services when producing underground (γ), the loss of income when operating underground (λ), and the tax ratio (τ).

The access agents operating underground enjoy to public goods and services captures the quality and functioning of public institutions as well. These aspects strongly determine to which extent agents operating underground incur losses due to their underground nature. This is also confirmed by the relative size of the losses the agents engaging in underground activities incur relative to the tax ratio. This measure equals 19.4% for the developed world and 12.4% for the developing world.

The simulations show a significant responsiveness of the size of the natural level of the underground economy to changes of the tax ratio and emphasize the importance of the tax ratio in explaining its size in this model. Still, large tax cuts are required to reduce the size of the natural level of the underground economy. On the other hand, it seems to suggest that relatively small tax increases would cause the natural level of the underground economy to expand strongly.

The model suggests as well that the authorities in the developed world are on aggregate exploiting all scope to levy taxes. Departing from the current tax position, further tax increases would significantly erode the tax base. However, while exploiting all scope to levy taxes, the authorities seem on aggregate to be operating slightly passed the point that maximizes tax revenues. The aggregate position passed this point might be related to the lack of exact knowledge regarding the structure of the economy or regarding the position of the economy relative to underground economic activities.

The opposite outcome is found for the developing countries. The authorities in the developing world are apparently not fully exploiting the scope to levy taxes, because the point where tax revenues are maximized lies ahead of the current position. So tax proceeds may be increased by raising taxes despite its expanding impact on the size of the (natural level of the) underground economy.

Finally, both aggregates of countries exhibit the pattern as prescribed by what used to be called the Laffer curve. There is a turning point up to where tax increases yield higher tax proceeds, and from where on tax proceeds start declining, if taxes are further increased. This result is obtained by accounting for the interaction between the tax burden and underground economic activities.

Chapter 5. The natural level of the underground economy and the fiscal stance

5. 1 Introduction

The underground economy has important fiscal repercussions. It erodes the tax base, causing tax losses. These losses impact the quantity and quality of the publicly provided goods and services. In addition, it may cause congestion, i.e. affect the quality of the publicly provided goods and services due to an excess of demand relative to its supply. Hence, it may affect the sustainability of the fiscal stance. Moreover, it may help explain the outcome of past efforts across the globe to restore fiscal sustainability.

Extensive research has been done into the variables determining the outcome of fiscal consolidation. But the role of the underground economy had not yet been considered. This chapter does; its focus is to assess whether the underground economy may help explain the outcome of consolidation efforts. This analysis is performed by means of a descriptive data analysis and by means of a Probit model.

This chapter is structured as follows. The next section discusses the concept of fiscal sustainability. The third section presents a literature review on fiscal consolidation. In the fourth section, the data is described and discussed. Then, this chapter proceeds with the estimation and analysis of a Probit model. Finally, concluding remarks and observations are presented.

5. 2 Fiscal sustainability

Fiscal sustainability, i.e. whether the debt dynamics is sustainable, may be defined as a policy stance whose continuation in the infinite future does not violate the intertemporal budget constraint. It requires the outstanding debt to match the present value of the sum of the expected future primary balances. If gradual policy changes suffice to yield that outcome, the fiscal stance is still considered sustainable. But, if, on the contrary, drastic policy changes are required, the situation is called unsustainable. So, fiscal sustainability means that the government cannot run primary deficits permanently, but it does not exclude running primary deficits occasionally.

The government provides public goods and services. It is assumed that there is no monetary financing. So the provision of public goods and services is financed solely by levying taxes and by borrowing. A proportional tax on official output is assumed. The one period government budget constraint in real terms may be expressed as follows:

(1) $\dot{B}(t) = G(t) - T(t) + rB(t) = G(t) - \tau Y^{O}(t) + rB(t)$, where

$B(t)$ stands for the stock of outstanding public debt[15],

$G(t)$ stands for the primary public expenditures, i.e. exclusive of interest on the outstanding public debt,

r stands for the implicit interest rate on the outstanding public debt and is assumed constant,

$T(t)$ stands for the public revenues,

τ stands for the tax-to-output-ratio.

$Y^{o}(t)$ stands for the official Gross Domestic Product (GDP).

The budget constraint may also be presented with the variables expressed in terms of a ratio to GDP, as follows:

(2) $$\frac{\dot{b}(t)}{b(t)} = \frac{\dot{B}(t)}{B(t)} - \frac{\dot{Y}^{O}(t)}{Y^{O}(t)} = \frac{G(t) - T(t) + rB(t)}{B(t)} - y^{O}(t) = \frac{G(t) - T(t)}{B(t)} + \frac{rB(t)}{B(t)} - y^{O}(t) = \underbrace{\frac{g(t) - t(t)}{b(t)}}_{A} + \underbrace{\left[r - y^{O}(t)\right]}_{B}$$

[15] The debt may also change due to the revaluation of debt issued in foreign currency and statistical errors.

where b_t stands for the stock of outstanding public debt as a ratio to GDP, r is the implicit interest rate on the outstanding public debt and $y^o(t)$ is the official economic growth rate.

The budget constraint in equation (2) shows that the dynamics of the debt ratio is determined by two terms, given by A and B. Term A represents net public borrowing or net public lending, excluding interest payments on the outstanding public debt. This equals the difference between the primary public expenditures and the public revenues. Hence, it is the opposite of the broadly known term primary balance.

Term B gives the relation between the official economic growth rate and the implicit interest rate on the outstanding public debt. If the interest rate exceeds the economic growth rate, a primary surplus is needed to keep the debt ratio constant. If, on the contrary, the economic growth rate exceeds the interest rate, primary deficits may be compatible with stable debt ratios. So sustainability may be ensured or restored through the primary balance and/or economic policy by influencing the interest rate and the economic growth rate.

A stable debt ratio, i.e. $\dot{b}(t) = 0$, requires:

(3) $$\dot{b}(t) = 0 \Rightarrow \frac{g(t) - t(t)}{b(t)} + \left[r - y^{O}(t) \right] = 0 \Leftrightarrow t(t) - g(t) = \left[r - y^{O}(t) \right] b(t)$$

So sustainability of the public debt requires that the growth-adjusted debt service is financed by a primary surplus.

How does the underground economy affect fiscal sustainability?

The underground economy influences the fiscal stance. The underground economy erodes the tax base, thereby reducing the tax revenues. The estimates of the underground economy may be used to estimate the loss of revenue by the public sector due to the existence of underground activities, like done in Jardim (2007). These revenue losses affect the quantity and the quality of the publicly provided goods and services. The underground economy may also cause the demand for government goods and services to exceed the quantity and quality that the authorities are able to finance with the resources generated by the official economy (congestion). This may, of course, affect the sustainability of the fiscal stance.

A smaller (natural level of the) underground economy implies that the use of the existing public goods and services by underground agents diminishes. But it increases the demand for public goods and services by the new official agents. So, congestion will lessen only if the provision is extended to cope with the increased demand. This may pose a serious challenge to public finances, if the efficiency of the allocation of the public resources and the efficiency of the organization of the civil service are not addressed.

Fiscal sustainability is crucial for a sound economic development and price stability. Lack of fiscal sustainability affects the economy. Once cumulative deficits approach the future taxing capacity, the interest and inflation rates may rise, affecting investment and consumption, and causing a slowdown in economic growth. Continuous public debt growth, as a result of budget deficits, might be indicative of the government running a so-called Ponzi-game, which means that the government is rolling over its debt indefinitely and borrowing to meet interest payments.

A benefit of fiscal sustainability is that it allows the authorities to provide the appropriate quantity and quality of public goods and services, because the authorities are no longer permanently strangled by budget deficits, and increasing debt services, that absorb more and more financial resources. Under these circumstances, the authorities have more financial resources to manage the economy and to establish the rule of law.

So, the authorities should try and reduce the size of the (natural level of the) underground economy, because less underground economic activity implies a broader tax base. This benefits fiscal sustainability. This outcome applies only if four conditions are met:

1. The reduction of the size of the (natural level of the) underground economy should not affect the viability of the activities that were previously performed underground.
2. Hence, the reduction of the size of the (natural level of the) underground economy should effectively broaden the tax base and generate additional fiscal revenues.
3. The additional fiscal revenues should mainly be used to balance the budget and pay off debt, if it is not sustainable at that moment.
4. The increased demand for public goods and services by the new official agents must be matched by more efficiency in the allocation of the public resources and more efficiency in the organization of the civil service.

In addition, a smaller underground economy implies a larger official economy, hence a larger official GDP. Since this is the denominator of the debt ratio this may contribute, through a lower debt ratio, to fiscal sustainability

5. 3 Fiscal consolidation

If the fiscal stance is not sustainable the question arises which consolidation policy shall yield fiscal sustainability. The following aspects are critical in designing the consolidation policy:

- How large should the consolidation efforts be?
- Should the authorities cut expenditures, raise revenues, or both?
- Which expenditures or revenues should be addressed?
- Should the authorities implement a short lived or gradual consolidation process?

- Will the consolidation programmes yield a sustainable outcome or will the improvements just be temporary?
- Shall the consolidation cause a recession?

Findings from the existing literature

Extensive literature analyzes the variables determining the outcome of fiscal consolidation. The literature commonly reports that the outcome of consolidation processes is strongly related to the type of consolidation. Type refers commonly to the extent to which the consolidation effort focuses on expenditure cuts or tax increases and whether the consolidation occurs gradually or not.

In their seminal paper Alesina and Perotti (1995) used data for OECD countries to investigate whether the composition of the consolidation program affects its outcome and its consequences for the economy. They defined two kinds of programmes. Type 1 relies mainly on the reduction of the primary current public expenditures, especially politically sensitive ones, like wages and salaries, subsidies and social security benefits. Tax increases do not contribute significantly to Type 1 consolidation programmes, and focus mainly on indirect taxes and profit taxes. Type 2 focuses on increasing public revenues, especially direct taxes and social security contributions. Expenditure cuts do not contribute significantly to Type 2 consolidation efforts, and, if any, tackle mainly investments.

According to them, consolidation programmes of Type 1 are more likely to be successful and to expand the economy, even when their size is the same. On the contrary, Type 2 consolidation programmes seem to be short lived: they are interrupted and shortly thereafter neutralized, resulting in the further worsening of the public finances and in the contraction of the economy.

This result was confirmed in several later studies, for instance Alesina and Perotti (1997), Giavazzi and Pagano (1996), McDermott and Wescott (1996), Alesina and Ardagna (1998), Perotti (1998), Giavazzi et al (2000), Von Hagen et al (2002), European Commission (2003), Briotti (2004), Lambertini and Tavares (2005) and Guichard et al (2007). These results seem to suggest that consolidation programs should focus on cutting expenditures, especially those that exhibit an automatic growth.

On the other hand, Heylen and Everaert (2000), Von Hagen et al (2001), Ardagna (2007) and Venes (2009) found no evidence that successful consolidation efforts are mainly expenditure based.

In addition, Guichard et al (2007) and Venes (2009) found that the initial conditions and duration of fiscal episodes matter. The fiscal conditions prevailing just before the start of a consolidation episode seem to influence the size of consolidation efforts: large initial deficits and high interest rates trigger fiscal adjustments and boost the overall size and duration of the consolidation programmes. This suggests that difficult initial conditions raise the awareness of the public for the extent of the fiscal problems and make it easier for the authorities to act. Institutional features also seem to influence the outcome of fiscal consolidation efforts. Longer lasting fiscal consolidation programmes are also found more successful.

The role of the underground economy

Given the broad empirical support for the view that the composition of the fiscal adjustment influences the outcome of fiscal consolidation episodes, this aspect is further studied.

The relative success of expenditure based adjustment programmes may be explained by the fact that personnel expenses and social security benefits are usually tackled. This kind of policies is politically more sensitive and may have more lasting effects. Moreover, fiscal consolidation programmes with this kind of characteristics signal a stronger commitment by the authorities to achieve fiscal sustainability.

But the relative success of expenditure based adjustment programmes may also be related to the interaction between the consolidation strategy and the underground economy. Expenditure cuts are sustainable only if the way of doing business in the public sector is restructured or by redefining the tasks of the public sector. This may contribute to simplify and reduce the regulatory burden. Since regulations are empirically found to cause underground activities, as noted in Chapter 2, these programmes may enhance official operations and contribute to reduce the incentives to operate underground. On the other hand, consolidation programmes that focus on increasing taxes, which are one of the main causes of the underground economy, as noted in Chapter 2, make underground activities more attractive.

So expenditure based fiscal consolidation programmes may contribute to reduce the size of the (natural level of the) underground economy, while fiscal consolidation programmes that focus on increasing taxes may contribute to increase its size. Considering the negative impact of the underground economy on the fiscal stance, as observed earlier, this differentiated impact of the consolidation programmes on the size of the underground economy may explain the success of expenditure based consolidation programmes relative to consolidation programmes that focus on increasing taxes.

It is, therefore, crucial to understand how the underground economy is affecting the fiscal stance, the way the underground economy might affect the effectiveness of fiscal consolidation programmes and how to deal with this. If the (natural level of the) underground economy is large and contributing to the lack of fiscal sustainability, fiscal consolidation programmes should address the (natural level of the) underground economy. Moreover, the appropriate fiscal consolidation strategy may itself have to internalize the underground economy, and in particular the position of the economy with regard to critical fiscal thresholds.

The size of the official economy in the decentralized macroeconomic steady state was derived in Chapter 3. That outcome is reproduced in equation (4)[16].

$$(4)\quad \overline{Y}^{o}\Big|_{D} = A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(\overline{K}^{o}\right)^{1-\alpha} = A^{1/\alpha} * \left(\frac{G(t)}{\overline{K}}\right) * \left(\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right)^{\frac{1-\alpha}{\alpha}}$$

The official output in the decentralized steady state equilibrium reacts to changes of the amount of public goods and services supplied (G) and to changes of the tax rate (τ),as given in equation (5).

$$(5)\quad d\overline{Y}^{o} = \frac{\partial \overline{Y}^{o}}{\partial G} dG + \frac{\partial \overline{Y}^{o}}{\partial \tau} d\tau$$

$$\text{where } \frac{\partial Y^{O}}{\partial G} = \underbrace{A^{\frac{1}{\alpha}}}_{+} * \underbrace{\left(\frac{1}{K(t)}\right)}_{+} * \underbrace{\left[\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}}}_{+} > 0$$

[16] D stands for decentralized macroeconomic steady state.

$$\frac{\partial Y^O}{\partial \tau} = \underbrace{-}_{-}\underbrace{A^{\frac{1}{\alpha}}}_{+} * \underbrace{\left(\frac{G(t)}{K(t)}\right)}_{+} * \underbrace{\frac{1-\alpha}{\alpha}}_{+} * \underbrace{\frac{(1-\alpha)}{\rho+\delta}}_{+} * \underbrace{\left[\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right]^{\frac{1-2\alpha}{\alpha}}}_{+} < 0$$

The model predicts the expected relations between the size of the official economy, and the public expenditures and the tax burden, respectively. Increasing public expenditures expands demand, increasing the size of the (official) economy. In addition, the increase of public expenditures may be associated with an extension or improvement of the public goods and services supplied. This makes official operations more attractive, expanding the size of the official economy.

A tax hikes limits the purchasing power of consumers, shrinking the economy. In addition, the tax hikes makes official operations less attractive, causing the official economy to shrink.

The authorities may either cut expenditures or increase taxes to yield fiscal sustainability. To determine the appropriate policy, the authorities should also know the sensitivity of the size of the official economy to changes in these parameters, since this affects tax revenues. This can be assessed by calculating the relative elasticity of the size of the official economy in relation to changes in these parameters, as presented in equation (6).

$$(6)\quad \left|\frac{\varepsilon_{Y^o,G}}{\varepsilon_{Y^o,\tau}}\right| = \left|\frac{\frac{\partial Y^O}{\partial G}\frac{G}{Y^O}}{\frac{\partial Y^O}{\partial \tau}\frac{\tau}{Y^O}}\right| = \left|\frac{\frac{\partial Y^O}{\partial G}}{\frac{\partial Y^O}{\partial \tau}}\right| * \left|\frac{\frac{G}{Y^O}}{\frac{\tau}{Y^O}}\right| = \left|\frac{\frac{\partial Y^O}{\partial G}}{\frac{\partial Y^O}{\partial \tau}}\right| * \left|\frac{G}{\tau}\right|$$

Assuming that the last factor in equation (6) is constant, the responsiveness of the official output to changes in the policy parameters can be assessed by analyzing the first factor. This is done in equation (7).

$$(7)\quad \left|\frac{\frac{\partial Y^{O}}{\partial G}}{\frac{\partial Y^{O}}{\partial \tau}}\right| = \left|\frac{A^{\frac{1}{\alpha}} * \left(\frac{1}{K(t)}\right) * \left[\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}}}{-A^{\frac{1}{\alpha}} * \left(\frac{G(t)}{K(t)}\right) * \frac{1-\alpha}{\alpha} * \frac{(1-\alpha)}{\rho+\delta} * \left[\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right]^{\frac{1-2\alpha}{\alpha}}}\right| = \left|\frac{\alpha(1-\tau)}{(1-\alpha)G(t)}\right| = \left|\underbrace{\frac{\overset{\le 1}{\alpha}\,\overbrace{(1-\tau)}^{\le 1}}{\underbrace{(1-\alpha)}_{<1}}}_{\substack{\tau>\alpha,\\ \text{so } <1}}\right| * \left|\underbrace{\frac{1}{G(t)}}_{<1}\right| < 1$$

Inserting this outcome in equation (6) determines that for the same relative change, the tax burden has a larger impact on the size of the official economy.

5. 4 Data

This section establishes definitions for the following concepts:

1. Episode of fiscal consolidation
2. Successful fiscal consolidation episode
3. The role of the natural level of the underground economy in explaining the outcome of fiscal consolidation episodes.

The data used for this purpose is discussed in detail in Appendix 5.A. The data is reported in the Appendices 5.B to 5.V.

<u>Defining episodes of fiscal consolidation</u>

An episode of fiscal consolidation is defined in this thesis as a discretionary effort to restore fiscal sustainability. In order to focus on discretionary policy actions it is important that the measure of the fiscal stance is not influenced by the business cycle. Economic growth influences public finances in two ways. Faster growth implies larger tax revenues and reduced disbursements for social security. The deficit and public debt ratios to GDP are also reduced by the larger value of the denominator. So, in a favourable phase of the business cycle, the deficit and public debt ratios tend to decline through the two channels mentioned above, even when authorities do not implement discretionary fiscal adjustments.

It is also important to abstract from interest payments since these reflect earlier borrowing and are affected by changes in monetary policy as well, unless the consolidation leads to a lower interest rate or measures are taken to reduce the public debt.

Therefore, the cyclically-adjusted primary budget balance as a percentage of Gross Domestic Product (CAPB) is the most appropriate measure to identify and measure episodes of fiscal consolidation. This is the primary budget balance that prevails if the economy is operating at its potential. The fiscal impulse is measured as the yearly change of the CAPB, i.e. the first difference of the CAPB.

The cyclically-adjusted budget balance is the official indicator in the fiscal surveillance framework employed by the European Union to capture the budgetary effects of discretionary fiscal policy. For a detailed discussion of the cyclical-adjustment method used in that framework see European Commission (2004). This measure is also used by major international economic organizations, like the International Monetary Fund and the Organisation for Economic Cooperation and Development.

The first difference of the CAPB might not be zero even when there is no discretionary policy action. So, it is important to identify real attempts to improve public finances. The CAPB data is further discussed in Appendix 5.A. Due to the lack of data, the cyclically-adjusted budget balance as a percentage of Gross Domestic Product (CAB) is used instead for the developing world.

Contrary to Alesina and Perotti (1995 and 1997), McDermott and Wescott (1996) and Venes (2009), who arbitrarily set thresholds regarding the size and length of the fiscal adjustment, here the thresholds are derived from the data. As explained in Appendix 5.W., the same procedure as adopted in Zaghini (2001) is applied to identify relevant fiscal episodes.

Definition 1

Based on the sample data the definition for a fiscal consolidation episode is:

- *There is an episode of fiscal consolidation if the CAPB in the developed world or CAB in the developing world as a percentage of GDP improves by at least half the size of the standard deviation: 0.705*[17] *in one year for developed countries and 1.983*[18] *in case of developing countries.*
- *It starts if the CAPB in the developed world or CAB in the developing world improves by at least half the size of the standard deviation in one year, or earlier if the adjacent years before exhibit an improvement of the CAPB or CAB, respectively, as well, though smaller.*
- *It continues as long as the CAPB or CAB, respectively, does not worsen.*
- *It ends once the CAPB in the developed world or CAB in the developing world deteriorates.*

According to this definition, over the period 1981 - 2008, the sample developed countries exhibit 68 fiscal consolidation episodes and the sample developing countries exhibit 39 fiscal consolidation episodes. The tables in Appendices U and V report the occurrence of these episodes and show that most consolidation episodes were implemented over a relatively long time-span. In fact, over the whole period under analysis, 55.9% of the fiscal consolidation episodes in the developed world lasted two years or more. In the developing world 59.0% of the fiscal consolidation episodes lasted two years or more.

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[17] This is half the standard deviation of the theoretical distribution.
[18] This is half the standard deviation of the sample.

As regards the size and timing of consolidation, two different types of consolidation episodes are distinguished. The first is characterized by a sharp fiscal adjustment effort concentrated in a short period of time. This strategy is commonly called a cold shower in the literature. The second type refers to a gradual consolidation episode, i.e. it is implemented over a longer period. So, the data suggests that the countries in the sample have rather preferred a strategy of gradualism than a cold shower strategy.

Defining a successful fiscal consolidation episode

Next, the impact of discretionary fiscal episodes on public finances is studied in order to identify successful and unsuccessful fiscal consolidation episodes. The measure commonly used to assess the successfulness of the fiscal consolidations is the public debt ratio.

For instance, according to McDermott and Wescott (1996) fiscal consolidation episodes are successful, if, by the end of the second year after concluding the consolidation, the debt ratio is at least 3 percentage points lower than the level observed in the last year of the adjustment. The requirement for the debt ratio to be lower two years after the end of the consolidation episodes intends to capture whether the consolidation efforts have not been reversed.

In addition to the arbitrary nature of the thresholds, this method exhibits the following deficiencies:

- Only the direct impact was considered ignoring that structural reforms may have a short-term limited effect but a large long-term effect or may contribute to cause a structural break that might not be immediately visible.
- Using the debt ratio and comparing it with its size at the end of the consolidation program may ignore that the debt ratio may already have declined during the

consolidation program. This makes it hard to find successful consolidation programmes.

- A relative reduction of the debt ratio may be a more appropriate measure, because it makes a difference whether the debt ratio decreases, for instance, from 60% to 55% or from 100% to 95%.

Since long-lasting consolidations are considered here, a significant reduction of the debt ratio might already have been achieved during the implementation. Based on this Zaghini (2001) concluded that the public debt ratio in the last year of the consolidation program does not properly represent the value of the public debt during the adjustment. Therefore, Zaghini (2001) chose the average of the public debt ratio over the full span of the consoldation episode as a reference level.

Venes (2009) considered a fiscal consolidation successful, if, three years after the end of the consolidation episode the CAPB had not deteriorated by more than half the minimum fiscal effort needed for a change of the CAPB to be considered a fiscal episode.

The successfulness of fiscal consoldation episodes is evaluated by comparing the public debt ratio at the end of the third year after the conclusion of the consolidation program with the public debt ratio prior to the start of the fiscal consoldation episode. This allows the measurement of the effects of the consolidation efforts that are achieved during the fiscal consolidation episode and its persistence as well. In addition, the relative reduction of the public debt ratio rather than its absolute reduction is considered here, following Zaghini (2001), because conditions of indebtedness are different across countries and over time.

Definition 2

An episode of fiscal consolidation is successful if at the end of the third year after the conclusion of the fiscal consolidation episode the public-debt-ratio is at least five percentage points lower than its value immediately before the start of the consolidation effort.

The 5% reduction is arbitrarily set, and intends to capture relevant fiscal consolidations. The time span of three years is also arbitrarily set, and intends to capture whether the fiscal consolidation is sustained or, on the contrary, has been reversed.

This definition renders 48 cases of successful fiscal consolidation episodes. The developed world reports 21 successful fiscal consolidation episodes and the developing world reports 27 cases as listed in Table 4.

Table 4. Successful fiscal consolidation episodes

	Length of the fiscal consolidation episodes			
	1 year	2 years	3 years	4 years and more
Developed world				
Belgium				1993-1998
Belgium	2001			
Denmark		2004-2005		
Finland			1996-1998	
Ireland			1986-1988	
Ireland				1991-1994
Ireland	1996			
Ireland	2000			
Ireland		2003-2004		
Italy			1995-1997	
Luxembourg	1997			
Netherlands	1996			
Portugal	1986			
Portugal	1995			

Table 4. Successful fiscal consolidation episodes *(continued)*

	Length of the fiscal consolidation episodes			
	1 year	2 years	3 years	4 years and more
Spain		1996-1997		
Sweden			1996-1998	
Sweden	2000			
Sweden		2004-2005		
Sweden		2007-2008		
United Kingdom		1988-1989		
United Kingdom				1994-2000
Number of fiscal consolidation episodes	8	6	4	3
Developing countries				
El Salvador			1993-1995	
Argentina		2003-2004		
Bolivia				2003-2006
Cameroon		2005-2006		
Côte d'Ivoire		2000-2001		
Ecuador	2006			
Ghana				2000-2003
Honduras		2004-2005		
Jordan	1992			
Jordan	1999			
Jordan		2003-2004		
Madagascar			1995-1997	
Madagascar	1999			
Madagascar		2005-2006		
Malaysia				1991-1994
Mexico				2000-2004
Morocco			1995-1997	
Morocco	1999			
Morocco		2006-2007		
Pakistan	2003			
Pakistan	2009			
Panama	1994			
Panama			2005-2007	
Paraguay	1990			
Paraguay		2003-2004		
Singapore			1992-1994	
Turkey			2003-2005	
Number of fiscal consolidation episodes	9	8	6	4

Defining the role of the natural level of the underground economy in explaining the outcome of fiscal consolidation episodes

The variables influencing the consolidation outcome have been discussed in Section 3. Most are conventional variables. The variables are described in Appendix 5. A. But one new variable is introduced here. It refers to the relative position of each country to the tax burden that maximizes tax revenues. Figure 6 and Figure 12 in Chapter 4 report the relation between the tax burden and the effective tax revenues as a percentage of the official GDP for the developed world and for the developing world, respectively. It shows that cutting the tax rate to 34.3% from 35.0% in the developed world would reduce the size of the natural level of the underground economy and contribute to raise more taxes at a lower tax burden.

Contrary to the developing world, Figure 6 in Chapter 4 suggests that there is limited scope in the developed world to improve public finances by increasing taxes. From the point of departure, further tax increases augment the size of the underground economy and cause tax losses. Higher taxes shift regular activity into the underground sector. Substitution of official activities by underground activities implies an erosion of the tax bases, causing a drop in public revenues. Then when tax rates are risen, only a fraction of the planned additional revenues are realized, since some revenues are foregone due to tax evasion, i.e. some serve to compensate the erosion of the tax base. So, budget control is necessary to manage both, the public debt and the underground economy.

In contrast, government spending has smaller effects on the underground economy, as proven earlier in Section 3. This may explain the relative unsuccessfulness of fiscal consolidations based on raising more taxes, as found in the literature mentioned in Section 3. This aspect has not been sufficiently addressed in previous empirical studies.

Definition 3

The role of the underground economy in explaining the outcome of fiscal consolidation episodes is assessed by considering the consolidation strategy, i.e. cutting expenditures or increasing revenues, each country undertakes relative to the fiscal threshold. The fiscal threshold is determined by the natural level of the underground economy. It is the tax burden up to where tax increases yield higher tax revenues and from where further tax increases induce a sufficiently large erosion of the tax base, due to an expansion of the (natural level of the) underground economy, such that the tax revenues decline. The tax revenues are maximized at the fiscal threshold.

Due to its importance in explaining the size of the natural level of the underground economy, the position relative to the fiscal threshold, in combination with the consolidation strategy, is intended to capture the role of the underground economy in explaining the successfulness of fiscal consolidation episodes.

The role of the underground economy is a binary variable constructed by multiplying two binary variables. The first one refers to the position relative to the fiscal threshold. This is measured by a binary variable that equals one (1) if the tax burden during the consolidation episode exceeds the fiscal threshold and zero (0) if the tax burden is lower than the fiscal threshold. The second one refers to the consolidation strategy, i.e. the extent to which the consolidation efforts is undertaken by cutting expenditures or raising more revenues. If increasing revenues represents more than half the consolidation effort the binary variable equals one (1) and zero (0) if not, i.e. if cutting expenditures is the main component of the consolidation strategy. This may be summarized as follows:

$$\text{RUE} = \begin{cases} 1 & \text{if fiscal consolidation is pursued by increasing revenues, while the tax} \\ & \text{burden exceeds the fiscal threshold} \\ 0 & \text{else} \end{cases}$$

The data is summarized in Table 5 and Table 6 for the developed world and for the developing world, respectively.

Table 5. Data summary - developed countries

	Successful	Unsuccessful	Average
Duration	2.333	2.149	2.206
Output-gap$_{t-1}$	-0.403	0.250	0.048
b_{t-1}	66.896	56.730	59.870
Index fiscal rules	0.213	-0.189	-0.065
dCAPB$_t$	2.816	3.067	2.990
Expenditure composition	0.571	0.456	0.491
τ-relative	0.0634	0.0632	0.0633
RUE	0.238	0.383	0.338
b_{t+3}	-0.194	0.277	0.132

Notes:

1. The Duration is the length of the fiscal consolidation episodes in years.
2. The Index of fiscal rules is the average during the fiscal consolidation episode.
3. The Expenditure composition refers to the average composition during the fiscal consolidation episode.
4. τ-relative refers to the average deviation from the fiscal threshold during the fiscal consolidation episode.

From the data in Table 5 it may be inferred that successful fiscal episodes last approximately two months longer than unsuccessful ones. This coincides with earlier evidence. The economic situation seems to be more adverse in advance of successful fiscal consoldation episodes, as evidenced by the negative output gap, in contrast with the positive output gap in advance of unsuccessful fiscal episodes.

The same applies to the fiscal stance and supports earlier evidence as well. This suggests that a worse fiscal stance may indeed force fiscal adjustment and may increase the awareness of the need to consolidate public finances. This strengthens sponsorship, increasing the successfulness of the fiscal consolidation effort.

Successful fiscal consolidation episodes seem to be associated with more fiscal rules, as shown in earlier research. The size of the fiscal adjustment as measured by the cumulative first difference of the Cyclically-adjusted primary budget balances as a percentage of Gross Domestic Product (CAPB) seems to have been approximately 0.25 percentage points of Gross Domestic Product smaller in successful fiscal consoldation episodes. Successful fiscal consoldation episodes seem to rely more heavily on expenditure cuts (57.1%) than unsuccessful ones (45.6%). This seems to suggest that the quality of the fiscal adjustment, i.e. extent to which the consolidation efforts is undertaken by cutting expenditures or raising more revenues, is more important than its size.

The sample countries exhibit on average a position beyond the fiscal threshold. The relative difference is slightly larger with successful fiscal episodes. This may explain the generalized choice by the countries in the sample for relatively more expenditure based fiscal adjustments, because tax increases cause under such circumstances a larger erosion of the tax base. The composite variable (RUE) indicates as well, that, compared to the successful episodes, the unsuccessful episodes relied relatively more on raising revenues despite the countries operating beyond the fiscal threshold. The consequent erosion of the tax base may explain the consolidation outcome.

Finally, from the data in Table 5 it may be inferred that successful fiscal episodes yield a reduction of the debt ratio of almost twenty percentage points of Gross Domestic Product (-19.4%). On the contrary, the debt ratio worsens almost twenty eight percentage points of Gross Domestic Product (27.7%) following an unsuccessful fiscal episode. The conclusions inferred above from the data in Table 5 are further assessed by means of a Probit model in the next section.

Table 6. Data summary – developing countries

	Successful	Unsuccessful	Average
Duration	2.222	1.833	2.103
Output-gap$_{t-1}$	-0.018	0.009	-0.009
b_{t-1}	90.108	60.745	81.073
Index fiscal rules	n.a.	n.a.	n.a.
$dCAB_t$	8.905	3.061	7.107
Expenditure composition	0.510	0.628	0.547
τ-relative	-0.037	-0.050	-0.041
RUE	0.259	0.083	0.205
b_{t+3}	-0.358	0.079	-0.224

Notes:

1. The Duration is the length of the fiscal consolidation episodes in years.
2. The Index of fiscal rules is the average during the fiscal consolidation episode.
3. The Expenditure composition refers to the average composition during the fiscal consolidation episode.
4. τ-relative refers to the average deviation from the fiscal threshold during the fiscal consolidation episode.

The data in Table 6 tell that successful fiscal episodes last approximately five months longer than unsuccessful ones, compared to a difference of two months in the developed world.

The negative output gap just before the start of the fiscal consolidation effort suggests that the economic situation is more adverse in advance of successful fiscal consolidation episodes. This contrasts with the positive output gap in advance of unsuccessful fiscal consolidation episodes. This result is the same as the one obtained for the developed world, though smaller.

The fiscal stance is worse in advance of successful fiscal consolidation episodes, and supports earlier evidence. But here the differences between successful and unsuccessful fiscal consolidation episodes are larger (29.4% of GDP compared to 10.2 % of GDP in the developed world).

Fiscal adjustments seem to have been larger with successful fiscal episodes, as found in earlier literature. The size of the fiscal adjustment, as measured by the first difference of the Cyclically-adjusted budget balance as a percentage of Gross Domestic Product (CAB), is approximately 5.84 percentage points of Gross Domestic Product larger with successful fiscal episodes. But successful fiscal episodes seem to rely relatively less on expenditure cuts (51.0%) than not-successful ones (62.8%). This seems to suggest that within the developing world increasing revenues contributes effectively to fiscal consolidation.

This is a different pattern from the developed world. Table 6 tells that within the developed world successful fiscal consolidation episodes rely more heavily on expenditure cuts. This difference is most probably related to the relative position of each group of countries vis-a-vis its fiscal threshold.

In fact, the developing world exhibits on average a position below its fiscal threshold, contrary to the developed world that exhibits on average a position beyond its fiscal threshold. This may explain the generalized choice by the developing countries in the sample for a more revenue based fiscal adjustment, because, under such circumstances, tax increases do not cause a large erosion of the tax base.

The composite variable (RUE) indicates too that compared to the unsuccessful episodes the successful episodes relied relatively more on raising revenues. This contrasts with findings in Table 5 regarding the developed world.

Finally, from the data in Table 6 it may be inferred that successful fiscal consolidation episodes yield a reduction of the debt ratio of almost thirty-six percentage points of

Gross Domestic Product (-35.8%). This is almost double the final result within the developed world. On the other hand, the debt ratio worsens almost eight percentage points of Gross Domestic Product (7.9%) as a result of unsuccessful fiscal episodes. This worsening is considerably smaller than the result in the developed world. The conclusions inferred above from the data in Table 6 are further assessed by means of a Probit model in the next section.

5. 5 Probit model

To evaluate the success of fiscal consolidations, some authors have estimated Logit and Probit models, for instance McDermott and Wescott (1996) and Venes (2009). The relevance of several of the variables discussed in Section 3 was assessed in those researches. But the underground economy has until now never been considered. The main innovation here is that the underground economy enters the model. The idea is to assess if the outcome of fiscal consolidations is influenced by the interaction between the fiscal consolidation strategy and the underground economy.

In the model the dependent variable assumes the value one if the fiscal consolidation episode is successful and the value zero if not. The model includes variables capturing the initial economic conditions, measured by the output gap in the year before the start of the fiscal consolidation episode, the initial fiscal conditions, measured by the debt ratio in the year before the start of the fiscal consolidation episode, the duration, size and the expenditure content of the fiscal adjustment, the existing framework of fiscal rules and the role of the underground economy.

The probability that the fiscal consolidation is successful is given by:

$$P(Y=1|X)=G(X\beta)$$

where $Y = \begin{cases} 1 & \text{if the fiscal consolidation episode is successful} \\ 0 & \text{if the fiscal consolidation episode is unsuccesful} \end{cases}$

and $X = \begin{cases} \text{duration} \\ \text{debt ratio} \\ \text{output gap} \\ \text{fiscal rules} \\ \text{expenditure composition} \\ \text{size} \\ \text{role underground economy} \end{cases}$

This procedure is pursued in two steps. First, the model is estimated without the variable capturing the role of the underground economy in the outcome of the fiscal consolidation episode. Next, the model is extended to include the role of the underground economy in the outcome of the fiscal consolidation efforts. The estimation outputs of the Probit models for the developed countries are reported in Table 7. The detailed estimation outputs are reported in Appendix 5. X.

Table 7. Initial estimation output - developed countries

	Model with no underground economy		Model with underground economy	
	Coefficient	Probability	Coefficient	Probability
DURATION	-0.1055	0.2964	-0.0612	0.5555
DEBT_RATIO	0.0004	0.9381	0.0062	0.2613
OUTPUT_GAP	-0.1002	0.1939	-0.0828	0.2922
FISCAL_RULES	0.3197	0.0683	0.3405	0.0578
EXPENDITURE_COMPOSITION	-0.3163	0.4738	-0.8484	0.1049
RUE			-0.8242	0.0459

It is obvious from Table 7 that most parameters are not statistically different from zero in the model with no underground economy. The model is next re-estimated removing the variable that is less significant, starting with the debt ratio. This procedure is repeated until the remaining variables are significant at 10% significance level. This leaves the model as reported in Table 8.

The inclusion of the role of the underground economy yields a different outcome. Following the same procedure to achieve a parsimonious model, the final outcome is reported in Table 8. The inclusion of the role of the underground economy renders all variables not statistically significant except for the variable capturing the role of the underground economy.

The negative sign associated with the variable capturing the role of the underground economy means that the underground economy is found to influence the outcome of fiscal consolidation episodes negatively. This outcome says that implementing revenue driven fiscal consolidations, while the tax burden exceeds the fiscal threshold, decrease its successfulness.

This suggests that earlier empirical findings that expenditure based fiscal consolidation efforts are more likely to be successful, may be related to the appropriateness of such fiscal consolidation strategies relative to the fiscal threshold, i.e. relative to the natural level of the underground economy. Most developed countries are operating passed the fiscal threshold. Under such circumstances, tax hikes erode the tax base and reduce the effectiveness and successfulness of the fiscal consolidation episodes. Hence, the benefits of expenditure based fiscal consolidation episodes in the developed world may lie in preventing this impact from revenue based fiscal consolidation strategies rather than in their intrinsic quality.

The same procedure is pursued for the developing world. The estimation outputs of the Probit models for the developing world are reported in Table 9. The detailed estimation outputs are reported in Appendix 5. X.

Table 9. Initial estimation output - developing countries

	Model with no underground economy		Model with underground economy	
	Coefficient	Probability	Coefficient	Probability
DURATION	-0.1563	0.5645	-0.1602	0.5598
DEBT_RATIO	0.0041	0.5745	0.0048	0.5588
OUTPUT_GAP	-8.1657	0.2901	-8.2009	0.2922
EXPENDITURE_COMPOSITION	-1.4493	0.0573	-1.5266	0.0803
SIZE	0.3135	0.1480	0.3197	0.1468
RUE			-0.1599	0.8503

Table 9 tells that most parameters are not statistically different from zero in the model with no underground economy. The model is next re-estimated removing the variable that is less significant, starting with the debt ratio. This procedure is repeated until the remaining variables are significant at 5% significance level. This leaves the model as reported in Table 10.

Table 10. Final estimation output - developing countries

	Model with no underground economy		Model with underground economy	
	Coefficient	Probability	Coefficient	Probability
DURATION				
DEBT_RATIO				
OUTPUT_GAP				
EXPENDITURE_COMPOSITION	-1.3265	0.0487	-1.3265	0.0487
SIZE	0.3057	0.0057	0.3057	0.0057
RUE				

The final model says that larger and more revenue based consolidation episodes increase the probability that the fiscal consolidation episode is successful. Like Heylen and Everaert (2000), Von Hagen et al (2001), Ardagna (2007) and Venes (2009), no evidence is found here that successful consolidation episodes are mainly expenditure based. On the contrary, revenue based consolidation efforts are found more successful.

This is not surprising considering the fact that most developing countries in the sample have tax burdens lower than the fiscal threshold. So, it is still possible to increase taxes without a significant erosion of the tax base.

The consistency of this outcome is tested by including the variable capturing the role of the underground economy (RUE). The inclusion of the role of the underground economy renders once again most variables not statistically significant. Following the same procedure to achieve a parsimonious model, the final outcome is reported in Table 10. The inclusion of the role of the underground economy does not change the final result, because it is not found statistically significant. This may be related to the position of most developing countries relative to the fiscal threshold.

5. 6 Conclusions

The existing literature exhibits a mixed view regarding the effectiveness of fiscal consolidation programmes that focus on cutting expenditures, especially politically sensitive ones, in relation to programmes that are based on tax increases. The length of the fiscal consolidation programme seems to influence its outcome as well: longer fiscal consolidation programmes are more likely to be successful, even when their size is the same.

Empirical research shows that the successfulness of fiscal consolidation programmes is also determined by the state of the public finances prior to the start of the fiscal consolidation episode. Public indebtedness ahead of successful fiscal consolidation episodes is found to be considerably larger than the one reported before unsuccessful episodes.

The descriptive analysis of the sample data conducted in this chapter shows that successful fiscal episodes last longer than unsuccessful ones. This gap is wider within the developing world due to shorter unsuccessful fiscal consolidation episodes (almost four months).

The economic conditions ahead of the fiscal consolidation, measured here by the output gap, are more adverse before successful fiscal episodes. This contrasts with the positive output gap in advance of unsuccessful fiscal episodes. The developed and developing world exhibit both the same pattern, but it is more pronounced within the developed world.

The fiscal stance, measured here by the debt ratio in the year before the start of the fiscal consolidation episode, is worse in advance of successful fiscal episodes, and supports earlier empirical evidence. But the difference between successful and unsuccessful fiscal consolidation episodes is larger within the developing world.

Successful fiscal consolidation episodes in the developing world seem to have been associated with larger fiscal adjustments, as found in earlier literature, in contrast with the developed world where successful fiscal consolidation episodes seem to have been associated with smaller fiscal adjustments.

Successful fiscal consolidation episodes in the developed world seem to rely more on expenditure cuts compared to the developing world. The opposite applies to unsuccessful ones.

This differing pattern seems to suggest that cutting expenditures is more effective than increasing revenues in the developed world and that increasing revenues is more effective than cutting expenditures in the developing world. This difference is most probably related to the relative position of each aggregate of countries to their respective fiscal threshold, i.e. the point from where further tax increases induce, via an expansion of the (natural level of the) underground economy, a sufficiently large erosion of the tax base that cause a decline of the tax revenues: the developed world exhibits on average a position beyond the fiscal threshold, in contrast with the developing world that exhibits a position below the fiscal threshold.

When the tax burden is lower than the fiscal threshold, tax increases cause a relatively smaller erosion of the tax base. This may explain the generalized choice in the developing world for more revenue based fiscal consolidation episodes. This choice is confirmed by the composite variable that jointly measures the relative position of the economy to the fiscal threshold and the fiscal consolidation strategy (RUE). This variable indicates that, within the developed world, successful fiscal consolidation episodes relied relatively more on cutting expenditures compared to unsuccessful fiscal episodes, and that, within the developing world, successful fiscal consolidation episodes relied relatively more on raising revenues.

Finally, from the sample data it may be inferred that the reduction of the public debt ratio is larger, following successful fiscal episodes in the developing world. Unsuccessful fiscal episodes in the developing world are, in contrast, followed by less intense worsening of the fiscal stance.

A Probit model was employed to further assess whether the interaction of the underground economy with the fiscal stance explains the success of fiscal consolidation episodes. The model was estimated separately for each aggregate of countries. The model was first estimated without the variable that captures the role of the underground economy in the outcome of the fiscal consolidation programme. Next, the model included the variable that captures the role of the underground economy in the outcome of fiscal consolidation programmes.

The estimation outputs show that the inclusion of the variable that captures the role of the underground economy in the outcome of fiscal consolidation programmes in the model for the developed world renders all variables statistically not-significant, except the variable capturing the role of the underground economy in the outcome of fiscal consolidation programmes. The underground economy is found to influence the outcome of fiscal consolidation episodes. In fact, it says that implementing revenue driven fiscal consolidations, while the tax burden exceeds the fiscal threshold, decreases its successfulness.

The same procedure was pursued for the developing world. Including the variable that captures the role of the underground economy in the outcome of fiscal consolidation programmes in the model for the developing world does not change the final estimation output. This variable is not found statistically significant. The final model says that larger and more revenue based fiscal consolidation programmes increase the probability that the fiscal consolidation episode is successful in the developing world. This is not surprising considering that the tax burden in most developing countries in the sample is lower than the fiscal threshold. This implies that it is still possible to increase taxes without a significant erosion of the tax base.

These findings suggest that earlier empirical findings that expenditure based fiscal consolidation programmes are more likely to be successful, may not result from its intrinsic quality. Expenditure based fiscal consolidation programmes may be the only appropriate strategy with regard to the fiscal threshold. The fiscal threshold is determined by the underground economy. Most developed countries are operating passed the fiscal threshold. From there, fiscal consolidation strategies based on tax increases cause a significant erosion of the tax base. At the end, the tax revenues decline which renders the fiscal consolidation episode ineffective and reduces its successfulness.

The developing countries have a tax burden which is in general lower than the fiscal threshold. This reduces the erosion of the tax base, as a consequence of the tax increase, and may explain why the underground economy does not seem to play a role in explaining the successfulness of fiscal consolidation episodes in the developing world.

No attention had ever been devoted to the role of the underground economy in explaining the effectiveness of fiscal consolidation programmes. Therefore, these findings provide useful insight that may improve the process of designing fiscal policy guidelines.

Chapter 6. Summary and concluding remarks

This thesis intended to address the following two questions:

1. Is there a natural level of the underground economy?
2. Does it influence the outcome of fiscal consolidation programmes?

The answers to these questions are crucial to understand whether underground economic activities are inevitable and to understand how the underground economy affects efforts to restore fiscal sustainability. If the natural level of the underground economy is large and responsible for the lack of fiscal sustainability, fiscal consolidation programmes should address it as well. In addition, the appropriate fiscal consolidation strategy may itself have to internalize the underground economy.

Defining the underground economy

To better understand the underground economy it is important to position it within total economic activity. Economic activity comprises two categories:

A. The measured economic activity, which is activity that is contained in the official statistics.

The official figures should contain an observed component and an imputed unobserved component. The observed component represents the economic activity that is reported to the statistics body. The unobserved component covers economic activity that is not captured by the data collection system, including underground activity, and that must therefore be imputed. This is in accordance with the OECD handbook (2002).

On the other hand, underground operations lack legal protection of the economic activities, they cannot conclude legally binding agreements with suppliers and customers, and they lack access to diversified sources of financing and governmental support programmes and to public goods and services in a broader sense. These represent costs for the agents when operating underground.

This cost-benefit analysis is conditioned by social norms, the effectiveness of the enforcement system and the quantity and quality of the public goods and services.

Social norms that condemn underground operations make it harder to operate underground, because no one wants to get stigmatized.

The effectiveness of the enforcement system determines the probability that agents get caught when operating underground. If caught, the agents may be stigmatized and they may face fines, which neutralizes the benefits they enjoyed while operating underground. The benefits that they did not enjoy, when operating underground, are, however, not recovered.

The quantity and the quality of the public goods and services too influences the decision to conduct an economic activity underground or not. A quantitatively and qualitatively vast offer of public goods and services makes it more attractive to operate in the official economy due to the restricted access to public goods and services when operating underground.

The importance of each cause or variable influencing the decision to operate underground or not varies among countries. This helps explain the size differences between countries vastly reported in empirical research.

The underground economy and its consequences

The underground economy is blamed for several economic problems. The underground economy erodes the tax base as it does not pay taxes or social contributions. This constrains public resources available to conduct public policies, affecting the quantity and the quality of the public goods and services. In addition, the quality of the publicly provided goods and services is affected by the excess of demand relative to the supply. This is called congestion. In summary, the underground economy affects the overall performance of public institutions and the sustainability of the fiscal stance.

The underground economy may also affect the overall competitiveness of the economy. In order to prevent detection by the authorities, agents are constrained in their choices when operating underground. For instance, they may be forced to adopt technology that is suitable for smaller production plants or even to adopt artisanal production procedures. These plants are more easily kept undetected. But this affects productivity, hence the overall competitiveness of the economy, and causes poor economic performance.

The underground economy is also responsible for the unfair competition that official agents face from the agents operating underground. Official agents pay taxes and social security contributions, and comply with the regulations applicable in the official economy. Agents operating underground do not. If the competition gets extremely unfair, normally viable economic operations may become unviable. This affects the overall competitiveness of the economy and the economic performance as well.

Further on, the underground economy distorts incentives. The allocation of resources in the economy is then not efficiently driven, which influences the structure of the economy. This distortion affects the overall competitiveness of the economy, causing poor economic performance.

Underground operations are also associated with less social security and unsafe working conditions. Underground employees are usually not covered by the social security network: they are not entitled to unemployment benefits, to public pension schemes or to medical care. The bargaining power of underground employees is also constrained, because they lack protection by the official labour laws. Underground employees are also more frequently exposed to unsafe working conditions due to their limited bargaining power and/or the understanding that those conditions are inevitable to keep the underground activity undetected or viable and preserve their job.

Is there a natural level of the underground economy?

The discussion above tells that the underground economy is not beneficial for economic growth and welfare. Based on this discussion, it is legitimate to ask why the authorities tolerate underground activities, or rephrasing it: Why do the authorities not exterminate the underground economy? Or do the authorities not succeed in this goal, because there is a natural level of the underground economy?

This thesis answers this question. It seems obvious to assume that the authorities pursue the maximization of the welfare of their citizens. But when pursuing this goal, the authorities might be forced to tolerate some underground economic activity. This is further discussed next.

Earlier research proves that taxes and regulations cause underground economic activities. It is, further on, unquestionable that any society needs taxes and regulations. Taxes are necessary to finance public policies: to finance the justice system, to finance the defence system, to guarantee broad access to education and health care, and to manage social differences through income transfers. Regulations are needed to protect citizens against abuses, to protect the environment, and to prevent excesses in general.

The inevitability of taxes and regulations turns the underground economy into a phenomenon that cannot be entirely eradicated. So the authorities face a trade-off between enhancing welfare and reducing the size of the underground economy. This trade-off forces the authorities to tolerate some underground economic activity. Underground economic activity should be extinguished up to the point where the benefits outweigh the costs. The corresponding size of the underground economy is called the natural level of the underground economy.

The natural level of the underground economy is defined as the level of underground economic activity that would prevail in the decentralized equilibrium, provided that the actual structural characteristics of the economy and social preferences[19], are accounted for by imbedding them in the Walrasian system of general equilibrium equations.

[19] Includes market imperfections, the cost of gathering information about underground economic activities and fighting underground economic activities, and the prevailing social norms of tax morale.

Similar to the natural rate of unemployment, the natural level of the underground economy responds to structural policies governing supply side factors. These factors are institutional, like the tax system, the regulatory framework, the quantity and the quality of public goods and services, and the social norms and beliefs.

Structural policies may have a temporary and a lasting effect on the size of the (natural level of the) underground economy. Structural policies may locally reduce both, but passed a threshold the same policies may strengthen the incentives to operate underground, expanding both. The same applies with regard to welfare. So there is scope for a trade-off. This is illustrated next.

Strict enforcement of the tax and regulatory framework adds to a smaller underground economy and fair competition. This expands the tax base, and as a consequence, increases public revenues. This allows either the provision of more and or better public goods and services, or tax cuts. Both positively impact the economic environment and welfare.

But additional resources may be needed to finance the strict enforcement of the tax and regulatory framework. If it turns out to be necessary to increase taxes, the final result might be the opposite of the one described above, as follows. The tax burden is one of the main structural causes of underground economic activities. So, tax increases may cause both, the underground economy and its natural level, to expand in the long-run. Higher taxes also reduce the disposable income and the purchasing power. This affects welfare.

The same applies, if strict enforcement of the tax and regulatory framework is financed by reallocating the actual tax proceeds, as this leaves fewer resources to finance the existing provision of public goods and services. This may translate into less or qualitatively poorer public goods and services. As the quantity and the quality of public goods and services is one of the main structural causes of underground economic activities, the expenditure shift may cause both, the underground economy and its natural level, to expand in the long-run. The move away from quantity and quality of public goods and services may hurt the economic environment and welfare too.

Tax cuts make underground activities less attractive and contribute to lower the size of the (natural level of the) underground economy in the short-run. The disposable income and the purchasing power benefit too from lower taxes. These consequences favour welfare.

But if the quantity and or the quality of the public goods and services are cut as a consequence of the lack of resources, following tax cuts, it may cause both, the underground economy and its natural level, to expand. This effect on the quantity and or the quality of public goods and services may affect the economic environment and welfare as well.

Relaxing the (enforcement of) regulations may improve the business environment, making it less attractive to operate underground. This may cause the underground economy and its natural level to shrink in the short-run. This may also benefit the economic environment and welfare. But relaxing the (enforcement of) regulations may also affect welfare due to exposure to, for example, unsafe or inhumane working conditions and environmental destruction.

So, in the short-run and in the long-run, there seems to be scope to simultaneously increase the official economy and welfare, but also scope for a trade-off. Since the total economy comprises official activities and underground activities, the same applies to the underground economy and the welfare in the following sense. If the official economy and welfare exhibit a positive relationship, the underground economy and welfare exhibit necessarily a trade-off, and vice-versa. It is more difficult to establish this relationship, if the target of the structural policies is to influence or change the social norms. In particular, because this kind of policies are more difficult to design and may also have a more lagged impact.

In summary, structural policies aimed at reducing the size of the natural level of the underground economy may have a positive short-run and long-run effect on the size of the underground economy and its natural level up to a certain point. Passed that point, the reduction of the (natural level of the) underground economy may involve such high costs that welfare starts declining. The level of underground activities associated with that turning-point corresponds with the natural level of the underground economy. This discussion was graphically translated into a hypothetical cut-off inverted U-shape relationship between the size of the underground economy and welfare, in the short-run and in the long-run. This does, however, not tell anything about the size of the natural level of the underground economy at the turning point.

Assessing the existence of a natural level of the underground economy

Earlier research has focused on the determinants of the underground economy and its consequences for the official economy. No attention has ever been devoted to assess the existence of a natural level of underground economic activity. This thesis innovates on this field. This is important to understand the limits to public policies. An important related field, public finances, is also studied.

To assess the existence of a natural level of the underground economy, this concept was first made operational. For this purpose, a simple general equilibrium model is constructed. The existence of a natural level of the underground economy and its size can be assessed using this model, because it proxies the definition adopted in this thesis for the natural level of the underground economy. In this model the structural characteristics of the economy and the social preferences are accounted for through production and utility functions. Markets are assumed competitive and market imperfections are ignored, among which the cost of gathering information about underground economic activities and the cost of fighting underground economic activities. In this model, the public revenues are fully devoted to supply public goods and services. No Walrasian system of general equilibrium equations is used as it cannot be operationalized, like Friedman (1968) did not.

The authorities pursue the maximization of welfare, but in doing so the authorities have to tolerate some underground economic activity. Centrally planned economies are very rare, so the authorities try to maximize welfare within the framework of the market-mechanism. The size of the underground economy at the decentralized market equilibrium is called the natural level of the underground economy.

Using the framework provided by the endogenous growth literature, two neoclassical general equilibrium models were constructed to assess the existence of the natural level of the underground economy. The first model assumes free mobility between the official economy and the underground economy, and homogenous agents that may operate simultaneously in both economies. The second model assumes free mobility between the official and underground economies too, but the agents are heterogeneous. Here, heterogeneity means that the agents cannot operate simultaneously in the official economy and in the underground economy. In the second model, an agent operates either in the official economy or in the underground economy.

In the decentralized equilibrium, the net marginal product of capital must be the same in the official economy and in the underground economy as a consequence of the free mobility assumption in both models. If the marginal product of capital were different, there would be an incentive to switch from one economy to the other economy, either way, depending on which had a larger marginal product of capital. The decentralized equilibria in the two models meet this requirement.

Both models predict the existence of underground economic activities in the decentralized equilibrium. This confirms the initial hypothesis that there is a natural level of underground economic activity. As noted earlier, this makes sense, because taxes, which are one of the main causes for the existence of underground economic activities, are accounted for in the models.

In addition to predicting the existence of a natural level of the underground economy, the two models predict the same size for it. This outcome too, is related to the free mobility assumption between the official economy and the underground economy. The assumptions regarding homogeneity and heterogeneity generate individual choices that are different for each model. But the similarity of the remaining structure of the models, and especially the free mobility assumption, generate the same resources devoted to underground economic activities at an aggregate level. The free mobility assumption is therefore key in explaining why both models predict the existence of a natural level of the underground economy and even the same size for it.

The models do, however, not reach the same result in the centralized equilibrium. The authorities act as a central planner in the centralized equilibrium. Contrary to the model with homogeneous agents, the authorities in the model with heterogeneous agents do not tolerate any underground economic activity in the centralized equilibrium.

This outcome is caused by the heterogeneity of the agents in the second model. Heterogeneous agents do not operate simultaneously in the official economy and in the underground economy; they operate either officially or underground.

Both models assume that the agents enjoy full access to public goods and services when operating in the official economy, and restricted access when operating in the underground economy. So, homogeneous agents are partially deprived from public goods and services, to the extent they operate underground. In contrast, heterogeneous agents operating underground face fully restricted access to public goods and services. This inconvenience adds to the restrictions the agents encounter when designing their production technology for underground economic activities. This explains why, in the model with heterogeneous agents, the central planner, who internalizes all aggregate advantages and disadvantages, is more inclined to favour official operations and tolerates no underground economic activity.

In addition, homogeneous agents do not pay taxes when operating underground. But they pay taxes related to their official operations. In contrast, heterogeneous agents that operate underground do not pay any taxes. This means that the tax base is in fact more severely eroded in the model with heterogeneous agents, when an agent decides to operate underground.

The authorities, i.e. the central planner, need a broad tax base to generate enough resources to finance public policies. The differentiated impact of underground operations on the tax base in the two models also explains why the authorities are less willing to tolerate underground economic activities in the model with heterogeneous agents. The outcome is that the authorities do not permit any underground economic activity in the centralized equilibrium. The actions of the authorities in the model with heterogeneous agents seem therefore to target the total eradication of the underground economy. From here, it may be concluded that the authorities in the model with heterogeneous agents perceive the costs of underground economic activities to clearly exceed its benefits.

Estimating the size of the underground economy and its natural level

Next, the model with homogeneous agents was calibrated for some developed and developing countries. This model was chosen for simulation purposes because it better resembles the real world by considering homogeneous agents, i.e. agents that may operate simultaneously in the official economy and in the underground economy, in contrast to heterogeneous agents. Agents engaging in underground economic activities, besides official economic activities, are more common than agents operating exclusively underground.

The calibrated model exhibits good adherence to the data. The model is able to reproduce the figures for the underground economy in the developed world quite well, individually and at an aggregate level as well. For the developing world, it suggests the underground economy is larger than estimated by Schneider and Buehn (2009).

This result is obtained with the calibrated parameters reflecting the expected relations. First, the official economy is more productive than the underground economy, in the developed and developing world. This is related to the unconstrained design of the production technology in the official economy, in contrast to the underground economy, where it is conditioned by the efforts to prevent the detection of the underground activities by the authorities.

Second, the official production and the underground production are more productive in the developed world. This is associated with the use of more advanced technology in the developed world and with the definition of capital used here. Capital is assumed to include human capital as well. More developed countries have in general more educated and better educated human resources, which translates into higher productivities.

Third, underground production uses public goods and services more intensely as inputs. Official production relies more on its own resources; public goods and services facilitate official production. This holds for developed and developing countries.

The contribution of public goods and services as inputs to official production in the developing world is larger than its contribution to underground production in the developed world. This may be related to economic and sociological characteristics of the developing world that enhance the dependency on the government, i.e. public goods and services, in those countries.

The access to public goods and services in the developed world by agents operating underground was assumed more restricted than in the developing world. This makes sense, because the authorities in the developing countries lack the resources, due to larger underground economies, to enforce regulations and set up qualitatively functioning public institutions. This makes it easier for agents engaged in underground economic activities in the developing world to use public goods and services, without exposing their underground nature. The agents engaged in underground economic activities in the developing world enjoy, therefore, broader access to the existing supply of public goods and services.

Further on, the underground production in the developed world is found to be as productive as the official production in the developing world. From here, it may be inferred that the restrictions developing countries face to access or implement more productive, i.e. more advanced, technology are stronger than the restrictions faced by agents in the developed world when selecting the underground production technology in a way to prevent detection.

Irrespective the similarities, like for instance, the handy man who enjoys more or less the same flexibility and faces more or less the same constraints, in developed and developing countries, when deciding which activities he performs officially and which activities he performs underground, this outcome may also be associated with a differing nature of the underground activities in the developed world from the developing world. The former may constitute a way to further improve the standards of living by taking advantage of the loopholes in the legal and regulatory systems. The latter is mainly a way of subsistence.

The economic structure may also help explain this outcome. The economy in the developed world is more knowledge and services based. In general, no production plants are needed to conduct those economic activities underground. For instance, many of those activities just require a computer and an internet connection. Those activities may be conducted at home, and go easily undetected. Or they may easily be classified as a hobby. The constraints when choosing the production technology to operate underground are then less severe. Consequently, the productivity of the agents is less severely affected when they operate underground.

In contrast, the economy in the developing world comprises relatively more manufacturing. The production plants are more difficult to keep undetected. Small or artisanal production plants are required to conduct those economic activities underground in an effort to keep the activity undetected. This means that the productivity of the agents is more severely affected when they operate underground.

Notwithstanding its good adherence to the data, as mentioned above, the model experiences some difficulty in estimating the natural level of underground economic activity when the tax burden is extremely high. The model is able to produce estimates for the natural level of the underground economy in developed countries for tax burdens that range from 0% up to 40.4% and in developing countries for tax burdens that range from 0% up to 27.4%. The model predicts that the natural level of the underground economy equals 0%, if the tax burden is 0% and, that starting from tax burdens of 40.4% and 27.4% the natural level of the underground economy equals 100% in developed countries and in developing countries, respectively. The natural level of the underground economy does not exceed 1% in developed countries and in developing countries for tax burdens up to 29.3% and 19.8%, respectively. This outcome is related to the strong explanatory role of the tax burden in this model.

Some developed countries reconcile very high tax burdens with small underground economies. The logic, that taxes drive agents into underground economic operations, as established in this model, dictates that this model should then, ceteris paribus, predict larger natural levels for the underground economy. But on the other hand, higher tax burdens allow the authorities to supply a broad range of public goods and services and set up qualitatively functioning public institutions that enforce compliance. This turns official operations more attractive and makes it harder to operate underground. This feature is not sufficiently captured in the model when the tax burden is relatively high. This applies to developing countries with relatively high tax burdens too.

On the other hand, based on the logic that taxes drive agents into underground economic operations, the model predicts low levels of natural underground economic activity in developing countries with relatively low tax burdens. But developing countries with large underground economies usually have low tax burdens. Following, the logic that low tax burdens turn official operations attractive, as established in this model, the model predicts, ceteris paribus, low natural levels of underground economic activity. But low tax burdens limit the resources available to the authorities and consequently constrain them in the provision of public goods and services and in the set up of qualitatively functioning public institutions that should enforce compliance. This makes it more attractive and easier to operate in the underground economy. This feature is not sufficiently captured in the model either, when the tax burden is relatively low.

The model estimates for the natural level of the underground economy tell that the underground economy is larger than structural features would suggest in many developed economies and most developing economies. Considering that the tax burden is higher in the developed world, their natural levels of the underground economy should be larger.

The smaller underground economies in the developed world suggest that the developed world limits the size of the natural level of the underground economy through the quantity and the quality of the public goods and services and through better enforcement. Qualitatively performing public institutions restrict the access to public goods and services by agents operating underground and impose higher losses to their underground operations.

The other variables in the model are only partially able to control for these aspects. This exposes some limitations of the model, which does not compromise its use for the purposes of this study. The model and its projections have been used taking these limitations into account. To deal with these limitations the model should be extended, i.e. by including additional relevant explanatory variables as discussed in Chapter 2, like the quality of the public goods and services, the social norms, the existence of burdensome and costly government regulations. This is why it has been emphasized that this model is particularly suitable for developed countries, with tax burdens ranging from 0% up to 40.4%, and for developing countries, with tax burdens ranging from 0% up to 27.4%.

Simulations

Simulations were performed for the key parameters in the model, that influence the size of the (natural level of the) underground economy:

a. the access to public goods and services when producing underground,

b. the loss of income when operating underground, and

c. the tax ratio.

The access agents operating underground enjoy to public goods and services captures (indirectly) the quality and functioning of the public institutions. These aspects strongly determine the extent of the losses incurred by the agents when operating underground.

The structure of the model establishes a positive linear relationship between the natural level of underground economic activity and the access underground agents enjoy to public goods and services. This means that unrestricted access to public goods and services coincides with larger natural levels of the underground economy.

The simulations also show a negative relationship in this model between the natural level of the underground economy and the income losses incurred by the agents when operating underground. The responsiveness of the size of the natural level of the underground economy to changes of the income losses when operating underground decreases the larger the income losses are.

This variable captures the quality and functioning of public institutions and the degree of enforcement of regulations and controls. Both aspects strongly determine the extent to which agents operating underground incur income losses due to their underground nature.

The simulations show that considerable efforts to limit the access of agents to public goods and services when operating underground or to squeeze the income earned underground are needed to achieve minor reductions of the natural level of the underground economy.

The simulations clearly expose the explanatory role of the tax ratio in this model with respect to the size of the natural level of the underground economy. Nonetheless, large tax cuts are required to reduce the size of the natural level of the underground economy. On the other hand, the model suggests that relatively small tax increases cause the natural level of the underground economy to expand strongly.

Simulations with the tax ratio show that both aggregates of countries exhibit the pattern as prescribed by what used to be called the Laffer curve. Indeed, there is a turning point up to where tax increases yield higher tax proceeds and from where on tax proceeds start declining, if taxes are further increased. Tax proceeds yield their maximum at the turning point.

The model suggests that the authorities in the developed world are, on aggregate, exploiting all scope to levy taxes. But, in doing so, the authorities seem, on aggregate, to be operating slightly passed the turning point. Any further tax increase, starting from the current tax position, would therefore significantly erode the tax base.

The opposite applies to the developing world. The authorities in the developing world are not fully exploiting the scope to levy taxes, because the turning point, where tax proceeds are maximized, lies ahead of the current position. In the developing world, tax proceeds may be increased by a tax hikes up to the turning point, 'irrespective' the expansion of the natural level of the underground economy it may cause.

The aggregate positions vis-a-vis the respective turning points might be related to the lack of exact knowledge regarding the structure of the economy or regarding the position of the economy with respect to underground activities.

The natural level of the underground economy and the fiscal stance

The underground economy has important fiscal repercussions and affects the sustainability of the fiscal stance, as mentioned earlier. The underground economy erodes the tax base, thereby reducing the tax revenues. The agents operating in the underground economy use public resources at the expense of the official economy. The quality of the public goods and services is then affected, if its demand exceeds its supply. This is called congestion. In addition, following the logic that taxes drive agents into underground economic operations, fiscal consolidation programmes that focus on increasing taxes, rather than cutting expenditures or broadening the tax base, tend to enlarge the underground economy.

The variables determining the outcome of fiscal consolidation programmes have been studied in earlier research. It delivers a mixed view regarding the composition of fiscal consolidation programmes. There is some evidence that fiscal consolidation programmes that rely on cutting expenditures, especially politically sensitive ones, are more likely to be successful, than those based on tax increases. But there is also evidence that points out the opposite.

The length of the fiscal consolidation programme was also found to influence its outcome in earlier empirical research; even when its size is the same, fiscal consolidation programmes that are spread over time are found to be more successful.

Earlier empirical research shows that the successfulness of fiscal consolidation programmes is also determined by the condition of the public finances before the start of the consolidation program. The public debt is found to be considerably larger ahead of successful fiscal consolidation episodes.

The role of the underground economy in the outcome of fiscal consolidation programmes has never been studied. This occurs for the first time in this thesis. The idea was to assess whether the underground economy may help explain the outcome of past fiscal consolidation episodes across the globe aimed at restoring fiscal sustainability.

Fiscal sustainability

Fiscal sustainability, i.e. whether the debt dynamics is sustainable, may be defined as a policy stance whose continuation in the infinite future does not violate the intertemporal budget constraint. It requires the outstanding stock of public debt to match the present value of the sum of expected future primary balances.

If gradual policies are sufficient to restore the balance between the outstanding stock of public debt and the present value of the sum of expected future primary balances, the fiscal stance is still considered sustainable. If, on the contrary, drastic policy changes are required, the situation is considered unsustainable.

Continuous primary deficits and consequently successive public debt growth might be indicative of the government running a so-called Ponzi-game. In that case, the government is rolling over its debt indefinitely and borrowing extra to meet interest payments. This is not compatible with fiscal sustainability. The opposite, running primary deficits occasionally, does not necessarily violate fiscal sustainability.

This thesis proves that the underground economy helps explain the effectiveness of past fiscal consolidation programmes across the globe. This analysis is performed through the descriptive analysis of the data and using Probit models.

The following three concepts were first introduced and defined:

Episode of fiscal consolidation

The definition of the concept episode of fiscal consolidation, based on the sample data, is:

- There is an episode of fiscal consolidation if the cyclically-adjusted primary budget balance as a percentage of Gross Domestic Product (CAPB) in the developed world or the cyclically-adjusted budget balance as a percentage of Gross Domestic Product as a percentage of GDP (CAB) in the developing world improves by at least half the size of its standard deviation.
- It starts if the CAPB in the developed world or CAB in the developing world in the developing world as a percentage of GDP improves by at least half the size of the standard deviation in one year, or earlier if the adjacent years before exhibit an improvement of the CAPB in the developed world or CAB in the developing world as well, though smaller.
- It continues as long as the CAPB in the developed world or CAB in the developing world does not worsen.
- It ends once the CAPB in the developed world or CAB in the developing world deteriorates.

This definition rendered, over the sample period 1981 - 2008, 68 fiscal consolidation episodes in the developed countries in the sample and 39 fiscal consolidation episodes in the developing countries in the sample. Most consolidation episodes were implemented over a relatively long time-span. In fact, over the whole period under analysis, 55.9% of the fiscal consolidation episodes in the developed world and 59.0% of the fiscal consolidation episodes in the developing world lasted two years or more. So, the data suggests that the countries in the sample have rather preferred a strategy of gradualism than a cold shower strategy. Sharp fiscal adjustments concentrated in a short period of time are commonly referred to as cold shower in the literature.

Successful fiscal consolidation episode

An episode of fiscal consolidation is successful, if at the end of the third year after its conclusion the public-debt-ratio is at least five percentage points lower than its value immediately before the start of the consolidation episode. The 5% reduction is arbitrarily set, and intends to capture relevant fiscal consolidations. The time span of three years is arbitrarily set, but intends to capture whether the fiscal consolidation is sustained or, on the contrary, has been reversed.

Role of the natural level of the underground economy in explaining the outcome of fiscal consolidations

The role of the natural level of the underground economy in explaining the outcome of fiscal consolidation episodes is assessed by considering the consolidation strategy, i.e. cutting expenditures or increasing revenues, each country undertakes relative to the fiscal threshold.

The fiscal threshold is determined by the natural level of the underground economy. It is the tax burden up to where tax increases yield higher tax revenues and from where further tax increases induce a sufficiently large erosion of the tax base, due to an expansion of the (natural level of the) underground economy, such that the tax revenues decline. This represents a turning point for the effective tax proceeds. At the fiscal threshold, i.e. at the turning point, the tax revenues are maximized and the size of the underground economy equals its natural level.

Descriptive data analysis

The descriptive analysis of the sample data shows that successful fiscal consolidation episodes last longer than unsuccessful ones. This gap is wider within the developing world. The duration of fiscal consolidation programmes in the developing world, both successful and unsuccessful, is shorter. Successful fiscal consolidation programmes are approximately one month shorter in the developing world. Unsuccessful fiscal consolidation programmes are almost four months shorter.

The economic conditions, measured by the output gap, are more adverse in advance of successful fiscal consolidation episodes. This contrasts with the positive output gap ahead of unsuccessful fiscal consolidation episodes. The developed and developing world exhibit the same pattern, but it is more pronounced in the developed world.

The fiscal stance, measured by the public debt ratio in the year before the start of the fiscal consolidation episode, is worse ahead of successful fiscal consolidation programmes. This is in line with earlier empirical evidence. The difference between successful and unsuccessful fiscal consolidation episodes is larger in the developing world.

Successful fiscal consolidation episodes in the developing world are associated with larger fiscal adjustments, like found in earlier literature. This contrasts with the developed world, where successful fiscal consolidation episodes are associated with smaller fiscal adjustments.

Successful fiscal consolidation episodes in the developed world seem to rely relatively more on expenditure cuts compared to the developing world. The opposite applies to unsuccessful ones.

This pattern suggests that cutting expenditures is more effective than increasing revenues in the developed world. Still, the data tells that expenditure cuts represent more than half of the fiscal adjustment in successful fiscal episodes in the developing world. But its contribution is smaller, i.e. the contribution from revenues is relatively larger.

This contrast is apparently related to the position of each aggregate of countries vis-vis the respective fiscal threshold. The fiscal threshold is the turning point up to where tax increases yield higher tax revenues and from where on further tax increases induce a sufficiently large erosion of the tax base, due to an expansion of the (natural level of the) underground economy, to cause a reduction of the tax revenues. At the turning point, the tax revenues are maximized and the economy is operating at its natural level of the underground economy.

The aggregate developed world exhibits a position beyond the fiscal threshold, in contrast to the aggregate developing world that exhibits a position below the fiscal threshold. When the tax burden is lower than the fiscal threshold, tax increases cause a relatively smaller erosion of the tax base. This may explain the generalized choice in the developing world for a relatively larger contribution of revenues to the fiscal consolidation programmes.

This choice is confirmed by a composite variable that has been constructed to jointly measure the relative position of the economy vis-a-vis the fiscal threshold and the consolidation strategy. The consolidation strategy refers to the extent the fiscal consolidation program is revenue or expenditure based.

This variable indicates that successful fiscal consolidation episodes in the developed world rely relatively more on cutting expenditures compared to unsuccessful fiscal consolidation episodes. It further indicates that, in contrast, successful fiscal consolidation episodes in the developing world rely relatively more on raising revenues.

From the sample data, it may also be inferred that, following successful fiscal consolidation episodes, the fiscal stance, measured by the debt ratio three years after the conclusion of the fiscal consolidation program, improves more significantly in the developing world than in the developed world. In contrast, unsuccessful fiscal consolidation episodes in the developing world are associated with a subsequent smaller worsening of the fiscal stance.

Analysis using Probit models

Probit models were employed to further assess the interaction between the natural level of the underground economy and the successfulness of fiscal consolidation programmes. The models were estimated separately for, respectively, the developed world and the developing world. The models were first estimated without the variable capturing the role of the underground economy in the outcome of the fiscal consolidation programmes. Next, this variable was included in the models.

The inclusion of the variable that measures the role of the underground economy in the outcome of the fiscal consolidation episodes, in the model for the developed world renders all variables statistically not-significant, except the variable that measures the role of the underground economy. The underground economy is found to influence the outcome of fiscal consolidation programmes in the expected way. It says that the successfulness of revenue driven fiscal consolidation programmes decreases when the tax burden exceeds the fiscal threshold.

The same procedure was pursued for the developing world. The variable that measures the role of the underground economy in the outcome of fiscal consolidation programmes was not found statistically significant. The estimation results tell that larger and relatively more revenue based fiscal consolidation programmes increase the probability that the fiscal consolidation episode is successful in the developing world. This outcome is not surprising, because most developing countries in the sample exhibit tax burdens lower than the fiscal threshold. In that case, it is still possible to increase taxes without causing a significant erosion of the tax base.

These findings suggest that earlier empirical findings that expenditure based fiscal consolidation programmes are more likely to be successful, may be related to the appropriateness of the fiscal consolidation strategy relative to the fiscal threshold, i.e with regards to the natural level of the underground economy. In that case, the advantages of expenditure based fiscal consolidation programmes lie in avoiding an erosion of the tax base rather than in its intrinsic quality.

When the tax burden is too high, i.e. passed the fiscal threshold, fiscal consolidation strategies based on tax increases cause a larger erosion of the tax base and compromise the successfulness of the fiscal consolidation program. The developed countries are operating mainly passed the fiscal threshold. Tax based fiscal consolidation programmes in the developed countries cause then the tax revenues to decline and produce the fiscal consolidation programme ineffective, shrinking its successfulness. Expenditure based fiscal consolidation programmes are then more appropriate.

At the opposite side, the tax burden in the developing countries is, in general, lower than the fiscal threshold. Then tax increases cause relatively smaller erosions of the tax base. This may explain why the underground economy does not seem to play a role in explaining the successfulness of fiscal consolidation episodes in the developing world.

Final remarks

The questions that were asked at the beginning of this thesis project have been satisfactorily answered. The existence of a natural level of the underground economy was first conceptually discussed and next proven using two neoclassical general equilibrium models that were constructed using the framework provided by the endogenous growth literature.

Regarding the question whether the underground economy influences the outcome of fiscal consolidation programmes, the answer has been found to be affirmative as well. Depending on the position of the economy relative to critical fiscal thresholds, that are associated with the concept of the natural level of the underground economy, the underground economy influences the outcome of fiscal consolidation programmes.

Based on these conclusions the process of designing appropriate and optimal fiscal policy guidelines, particularly those intended to restore fiscal sustainability, calls for:

1. A better understanding of the position of the economy relative to critical fiscal thresholds. It matters whether the economy is operating below or beyond the fiscal threshold where tax revenues are maximized.
2. The internalization of the natural level of the underground economy in the process of designing fiscal policies and particularly fiscal consolidation programmes due to its

inevitable nature. If the underground economy contributes to fiscal un-sustainability, the fiscal consolidation programmes should address the underground economy. In addition, the position of the economy relative to critical fiscal thresholds is to be accounted for when designing and outlining fiscal policies and fiscal consolidation programmes.

APPENDICES

APPENDICES CHAPTER 3

Appendix 3.A. A neoclassical general equilibrium model with underground activities and homogeneous agents: Decentralized equilibrium

Optimization problem of the representative household

This exercise starts solving the optimization problem for the representative household. The problem of the representative household is to maximize its utility by choosing c(t) subject to the individual intertemporal budget constraint.

$$\underset{\{c\}}{\text{Max}}\ U = \int_0^\infty U(c(t))e^{-\rho t}dt$$

s.t. $\dot{a}(t) = (1-\tau)y^o(t) + (1-\lambda)y^u(t) + ra(t) - c(t)$

The present value Hamiltonian for this optimization problem is:

$$H = \frac{c(t)^{1-\theta} - 1}{1-\theta} + s_1\left[(1-\tau)y^o(t) + (1-\lambda)y^u(t) + ra(t) - c(t)\right]$$

where s_1 is the co-state variable associated with the constraint.

The Pontryagin optimality conditions for this optimal control problem are:

Optimality condition

$$(3.A.1)\ \frac{\partial H}{\partial c(t)} = c(t)^{-\theta} - s_1 = 0 \Leftrightarrow c(t)^{-\theta} = s_1$$

Admissibility conditions

$$(3.A.2)\ \dot{a}(t) = (1-\tau)y^o(t) + (1-\lambda)y^u(t) + ra(t) - c(t)$$

$$(3.A.3)\ a(0) = a_0$$

Multiplier condition

(3.A.4) $\dot{s}_1 = \rho s_1 - \frac{\partial H}{\partial a(t)} = (\rho - r)s_1$

Transversality condition

(3.A.5) $\lim_{t \to \infty} s_1 a(t) e^{-\rho t} = 0$

Since the Hamiltonian is concave with respect to c(t) and a(t), these conditions are necessary and sufficient.

Time-differentiating (3.A.1) yields:

(3.A.6) $-\theta c(t)^{-\theta-1} \dot{c}(t) = \dot{s}_1$

and next substituting for s_1 and $\dot{s}_1$ from (3.A.1) and (3.A.4) respectively yields

$$
(3.A.7)\quad
\begin{aligned}
&-\theta c(t)^{-\theta-1} \dot{c}(t) = \dot{s}_1 \\
&-\theta c(t)^{-\theta-1} \dot{c}(t) = (\rho - r)s_1 \\
&-\theta \dot{c}(t) = (\rho - r)c(t) \\
&\dot{c}(t) = -\left[\frac{(\rho - r)}{\theta}\right] c(t)
\end{aligned}
$$

Consequently, the dynamical system is given by:

(3.A.8) $\dot{c}(t) = -\left[\frac{(\rho - r)}{\theta}\right]^{-1/\theta} c(t)$

(3.A.9) $\dot{a}(t) = (1 - \tau)y^{o}(t) + (1 - \lambda)y^{u}(t) + ra(t) - c(t)$

In the equilibrium $\dot{c}(t) = 0$ and $\dot{a}(t) = 0$, so

$\dot{c}(t) = 0 \Rightarrow (\varrho - r) = 0 \vee \bar{c} = 0$

$$\dot{a}(t) = 0 \Rightarrow (1-\tau)\bar{y}^{o} + (1-\lambda)\bar{y}^{u} + r\bar{a} - \bar{c} = 0 \Rightarrow \bar{c} = (1-\tau)\bar{y}^{o} + (1-\lambda)\bar{y}^{u} - r\bar{a}$$

The dynamics of this system in the neighbourhood of the equilibrium can be characterized through the properties of the Jacobian matrix (J). Determining the partial derivatives and substituting for the equilibrium values the trace, determinant and roots of the characteristic equation (λ_s and λ_u) can be derived. These describe the economic dynamics.

$$J = \begin{bmatrix} \frac{\partial \dot{c}}{\partial c} & \frac{\partial \dot{c}}{\partial a} \\ \frac{\partial \dot{a}}{\partial c} & \frac{\partial \dot{a}}{\partial a} \end{bmatrix}_{\dot{c}(t)=\dot{a}(t)=0} = \begin{bmatrix} -\left[\frac{(\rho - r)}{\theta}\right] & 0 \\ -1 & r \end{bmatrix}_{\dot{c}(t)=\dot{a}(t)=0} = \begin{bmatrix} 0 & 0 \\ -1 & r \end{bmatrix}$$

Hence tr(J)=r, which is always positive, and $|J| = 0$. This implies that λ_s=0 and λ_u=r. So the equilibrium is conditionally unstable. Further on, since tr(J) is positive there are no transitional dynamics in this economy.

Optimization problem of the representative firm

This exercise proceeds with the optimization problem of the representative firm. The problem of the representative firm is to maximize its profits by choosing $i^o(t)$ and $i^u(t)$, subject to the capital accumulation dynamics equations.

$$\underset{\{i^o, i^u\}}{\mathrm{Max}}\, U = \int_0^\infty \left[(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^o(t)^{1-\alpha} + (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^u(t)^{1-\beta} - i^o(t) - i^u(t) \right] e^{-rt} dt$$

s.t. $\dot{k}^o(t) = i^o(t) - \delta k^o(t)$

$\dot{k}^u(t) = i^u(t) - \delta k^u(t)$

where the output prices are normalized to 1. Since the agents do not distinguish the goods and services produced underground from those produced in the official economy, both have prices equal to 1. In addition, the profits are discounted using the market interest rate.

The present value Hamiltonian for this optimization problem is:

$$H = (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha} + (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{1-\beta} - i^{o}(t) - i^{u}(t) + p_1\left[i^{o}(t) - \delta k^{o}(t)\right] + p_2\left[i^{u}(t) - \delta k^{u}(t)\right]$$

where p_1 and p_2 are the co-state variable associated with the constraints.

The Pontryagin optimality conditions for this optimal control problem are:

Optimality conditions

(3.A.10) $\frac{\partial H}{\partial i^{o}(t)} = -1 + p_1 = 0 \Leftrightarrow p_1 = 1$

(3.A.11) $\frac{\partial H}{\partial i^{u}(t)} = -1 + p_2 = 0 \Leftrightarrow p_2 = 1$

Admissibility conditions

(3.A.12) $\dot{k}^{o}(t) = i^{o}(t) - \delta k^{o}(t)$

(3.A.13) $\dot{k}^{u}(t) = i^{u}(t) - \delta k^{u}(t)$

(3.A.14) $k^{o}(0) = k_0$

(3.A.15) $k^{u}(0) = k_u$

Multipliers conditions

(3.A.16) $\dot{p}_1 = rp_1 - \frac{\partial H}{\partial k^o(t)} = rp_1 - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^o(t)^{-\alpha} + \delta p_1$

(3.A.17) $\dot{p}_2 = rp_2 - \frac{\partial H}{\partial k^o(t)} = rp_2 - (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^u(t)^{-\beta} + \delta p_2$

Transversality conditions

(3.A.18) $\lim_{t\to\infty} p_1 k^o(t) e^{-rt} = 0$

(3.A.19) $\lim_{t\to\infty} p_2 k^u(t) e^{-rt} = 0$

Since the Hamiltonian is concave with respect to $i^o(t)$, $i^u(t)$, $k^o(t)$, and $k^o(t)$, these conditions are necessary and sufficient.

Substituting for p_1 from (3.A.10) in (3.A.16) and for p_2 from (3.A.11) in (3.A.17) yields:

(3.A.20) $p_1 = 1 \Rightarrow \dot{p}_1 = 0 \Leftrightarrow r - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^o(t)^{-\alpha} + \delta = 0 \Rightarrow k^o(t) = \left[\frac{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}}{r+\delta}\right]^{1/\alpha}$

(3.A.21) $p_2 = 1 \Rightarrow \dot{p}_2 = 0 \Leftrightarrow r - (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^u(t)^{-\beta} + \delta = 0 \Rightarrow k^u(t) = \left[\frac{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}}{r+\delta}\right]^{1/\beta}$

The dynamical system is given by:

(3.A.22) $\dot{k}^o(t) = i^o(t) - \delta k^o(t)$

(3.A.23) $\dot{k}^u(t) = i^u(t) - \delta k^u(t)$

In the equilibrium $\dot{k}^o(t)=0$ and $\dot{k}^u(t)=0$, so

$$\text{(3.A.24)} \quad \bar{i}^o = \delta\bar{k}^o = \delta\left[\frac{(1-\alpha)(1-\tau)A\left(\frac{\overline{G(t)}}{\overline{K(t)}}\right)^{\alpha}}{r+\delta}\right]^{1/\alpha}$$

$$\text{(3.A.25)} \quad \bar{i}^u = \delta\bar{k}^u = \delta\left[\frac{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}}{r+\delta}\right]^{1/\beta}$$

The dynamics of this system in the neighbourhood of the equilibrium can be characterized through the properties of the Jacobian matrix (J). Determining the partial derivatives and substituting for the equilibrium values the trace, determinant and roots of the characteristic equation can be derived. These describe the economic dynamics.

$$\text{(3.A.26)} \quad J=\left.\begin{bmatrix}\frac{\partial\dot{k}^o}{\partial i^o} & \frac{\partial\dot{k}^o}{\partial i^u}\\ \frac{\partial\dot{k}^u}{\partial i^o} & \frac{\partial\dot{k}^u}{\partial i^u}\end{bmatrix}\right|_{\dot{k}^o(t)=\dot{k}^u(t)=0} = \left.\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\right|_{\dot{k}^o(t)=\dot{k}^u(t)=0} = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$$

Hence tr(J)=2, which is always positive, and $|J|=1$. Since λ_s, λ_u>0, the equilibrium is unstable. Further on, there are no transitional dynamics in this economy.

From (3.A.20) and (3.A.21) it may be inferred that in the equilibrium the net marginal product of capital is the same in the official and in the underground sector, and equals the sum of the interest rate and the depreciation rate, as proven in (3.A.27) and (3.A.28).

$$\text{(3.A.27)} \quad (3.A.20) \Rightarrow \underbrace{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^o(t)^{-\alpha}}_{\substack{\text{marginal product of capital}\\ \text{in the official sector}}} = r+\delta$$

(3.A.28) $$(3.A.20) \Rightarrow \underbrace{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{-\beta}}_{\substack{\text{marginal product of capital}\\ \text{in the underground sector}}} = r+\delta$$

As a matter of fact, this is the only way for the economy to be in equilibrium. If these were different, there would be an incentive to shift production from one sector to the other, either way depending on which had a larger marginal product of capital.

To derive the relative size of the underground economy it is necessary to obtain first the expression for the official output, $y^{o}(t)$, and the underground output, $y^{u}(t)$. $y^{o}(t)$ and $y^{u}(t)$ are obtained in equation (3.A.29) and equation (3.A.30), respectively.

(3.A.29) $$y^{o}(t) = A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha} = A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left[\frac{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}} =$$

$$= A^{\frac{1}{\alpha}}\left(\frac{G(t)}{K(t)}\right)\left[\frac{(1-\tau)(1-\alpha)}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}}$$

and

(3.A.30) $$y^{u}(t) = B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{1-\beta} = B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left[\frac{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}}{r+\delta}\right]^{\frac{1-\beta}{\beta}} =$$

$$= B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right)\left[\frac{(1-\lambda)(1-\beta)}{r+\delta}\right]^{\frac{1-\beta}{\beta}}$$

So, the relative size of the underground economy (RSU_t) as given by the ratio of (3.A.30) and (3.A.29), comes:

$$\text{(3.A.31)}\qquad RSU_t = \frac{y^u(t)}{y^o(t)} = \frac{B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right)\left[\frac{(1-\lambda)(1-\beta)}{r+\delta}\right]^{\frac{1-\beta}{\beta}}}{\Lambda^{\frac{1}{\alpha}}\left(\frac{G(t)}{K(t)}\right)\left[\frac{(1-\tau)(1-\alpha)}{r+\delta}\right]^{\frac{1-\alpha}{\alpha}}} = \frac{(1-\lambda)^{\frac{1-\beta}{\beta}}}{(1-\tau)^{\frac{1-\alpha}{\alpha}}} * \frac{B^{\frac{1}{\beta}}}{\Lambda^{\frac{1}{\alpha}}} * \gamma * \frac{[1-\beta]^{\frac{1-\beta}{\beta}}}{[1-\alpha]^{\frac{1-\alpha}{\alpha}}} * [r+\delta]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}$$

Each factor in equation (3.A.31) is analyzed in the main text.

Appendix 3.B. A neoclassical general equilibrium model with underground activities and homogeneous agents: centralized equilibrium

The central planner determines the centralized equilibrium by maximizing the social well-being of all agents in the economy.

The social well-being is given by:

$$U = \int_0^\infty U(C(t))e^{-\rho t}dt \tag{3.B.1}$$

The central planner knows that $G(t)=\tau Y^o(t)$, hence $Y^o(t)$ comes:

$$\begin{aligned} &Y^o(t) = A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(K^o(t)\right)^{1-\alpha} = A\left(\frac{\tau Y^o(t)}{\overline{K}}\right)^{\alpha}\left(K^o(t)\right)^{1-\alpha} \Rightarrow \left(Y^o(t)\right)^{1-\alpha} = A(\tau)^{\alpha}\left(\frac{1}{\overline{K}}\right)^{\alpha}\left(K^o(t)\right)^{1-\alpha} \\ &\Rightarrow Y^o(t) = \left[A(\tau)^{\alpha}\left(\frac{1}{\overline{K}}\right)^{\alpha}\left(K^o(t)\right)^{1-\alpha}\right]^{\frac{1}{1-\alpha}} = \left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}K^o(t) \end{aligned} \tag{3.B.2}$$

while $Y^u(t)$ comes:

$$\begin{aligned} &Y^u(t) = B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(K^u(t)\right)^{1-\beta} = B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^u(t)\right)^{1-\beta} = B\left(\frac{\gamma\tau Y^o(t))}{\overline{K}}\right)^{\beta}\left(K^u(t)\right)^{1-\beta} \\ &\Rightarrow Y^u(t) = B\left(\frac{\gamma\tau}{\overline{K}}\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}K^o(t)\right)^{\beta}\left(K^u(t)\right)^{1-\beta} = B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}K^o(t)\right)^{\beta}\left(K^u(t)\right)^{1-\beta} \\ &= B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{1}{1-\alpha}}K^o(t)\right)^{\beta}\left(K^u(t)\right)^{1-\beta} = B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(K^o(t)\right)^{\beta}\left(K^u(t)\right)^{1-\beta} \end{aligned} \tag{3.B.3}$$

Each household allocates a fraction of its resources in the official sector and a fraction in the underground sector. It is assumed that the income earned from underground activities is residual. This means that the main income source is from official activities.

Accordingly, it is assumed that the income earned officially is sufficient to cover consumption.

This yields for $\dot{K}^o(t)$:

(3.B.4) $$\dot{K}^o(t) = I^o(t) - \delta K^o(t) = (1-\tau)Y^o(t) - C(t) - \delta K^o(t) = (1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}} K^o(t) - C(t) - \delta K^o(t)$$

and for $\dot{K}^u(t)$

(3.B.5) $$\dot{K}^u(t) = I^u(t) - \delta K^u(t) = (1-\lambda)Y^u(t) - \delta K^u(t) = (1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta \left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}} \left(K^o(t)\right)^\beta \left(K^u(t)\right)^{1-\beta} - \delta K^u(t)$$

So the central planner solves the following problem:

$$\underset{\{C(t)\}}{\text{Max}}\ U = \int_0^\infty U(C(t))e^{-\rho t}dt$$

$$\text{s.t. } \dot{K}^o(t) = (1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}} K^o(t) - C(t) - \delta K^o(t)$$

$$\dot{K}^u(t) = (1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta \left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}} \left(K^o(t)\right)^\beta \left(K^u(t)\right)^{1-\beta} - \delta K^u(t)$$

The present value Hamiltonian for this optimization problem is:

$$H = \frac{C(t)^{1-\theta}-1}{1-\theta} + v_1\left[(1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}} K^o(t) - C(t) - \delta K^o(t)\right] + v_2\left[(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta \left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}} \left(K^o(t)\right)^\beta \left(K^u(t)\right)^{1-\beta} - \delta K^u(t)\right]$$

where v_1 is the co-state variable associated with constraint (3.B.4) and v_2 the co-state variable associated with constraint (3.B.5).

The Pontryagin optimality conditions for this optimal control problem are:

Optimality condition

(3.B.6) $$C(t)^{-\theta} - v_1 = 0 \Leftrightarrow C(t)^{-\theta} = v_1$$

Admissibility conditions

(3.B.7) $$\dot{K}^{o}(t) = (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}} K^{o}(t) - C(t) - \delta K^{o}(t)$$

(3.B.8) $$\dot{K}^{u}(t) = (1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta} - \delta K^{u}(t)$$

(3.B.9) $$K^{o}(0) = K^{o}_{0}$$

(3.B.10) $$K^{u}(0) = K^{u}_{0}$$

Multiplier condition

(3.B.11) $$\dot{v}_1 = \left[\rho + \delta - (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]v_1 - \left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]v_2$$

(3.B.12) $$\dot{v}_2 = \left[\rho + \delta - (1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta}\right]v_2$$

Transversality condition

(3.B.13) $$\lim_{t\to\infty} v_1 K^{o}(t)e^{-\rho t} = 0$$

(3.B.14) $$\lim_{t\to\infty} v_2 K^{u}(t)e^{-\rho t} = 0$$

Since the Hamiltonian is concave with respect to C(t), $K^{o}(t)$ and $K^{u}(t)$, these conditions are necessary and sufficient.

Time-differentiating (3.B.6) yields:

(3.B.15) $$-\theta C(t)^{-\theta-1}\dot{C}(t) = \dot{v}_1$$

and next substituting for v_1 and $\dot{v}_1$ from (3.B.6) and (3.B.11), respectively, yields

$$
\begin{aligned}
& -\theta C(t)^{-\theta-1}\dot{C}(t) = \dot{v}_1 \\
& \Leftrightarrow -\theta C(t)^{-\theta-1}\dot{C}(t) = \left[\rho+\delta-(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]v_1 - \left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]v_2 \\
\text{(3.B.16)}\quad & \Leftrightarrow -\theta C(t)^{-\theta-1}\dot{C}(t) = \left[\rho+\delta-(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]C(t)^{-\theta} - \left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]v_2 \\
& \Leftrightarrow \dot{C}(t) = -\frac{1}{\theta}\left[\rho+\delta-(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]C(t) + \frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]v_2 C(t)^{\theta+1}
\end{aligned}
$$

Consequently the dynamical system is given by:

(3.B.17) $$\dot{C}(t) = -\frac{1}{\theta}\left[\rho+\delta-(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]C(t) + \frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]v_2 C(t)^{\theta+1}$$

(3.B.18) $$\dot{K}^{o}(t) = (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}K^{o}(t)\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}} - C(t) - \delta K^{o}(t)$$

(3.B.19) $$\dot{K}^{u}(t) = (1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta} - \delta K^{u}(t)$$

(3.B.20) $$\dot{v}_2 = \left[\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta}\right]v_2$$

In the equilibrium $\dot{C}(t)=0$, $\dot{K}^{o}(t)=0$, $\dot{K}^{u}(t)=0$ and $\dot{v}_2(t)=0$, so

(3.B.21) $$\dot{C}(t)=0 \Rightarrow -\frac{1}{\theta}\left[\rho+\delta-(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]\bar{C} + \frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]\bar{v}_2\bar{C}^{\theta+1} = 0$$

Since in the equilibruim $(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}=\rho+\delta$,

$$\dot{C}(t)=0 \Rightarrow \frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]\overline{v}_2\overline{C}^{\theta+1}=0$$

$$\Leftrightarrow \frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]=0 \vee \overline{v}_2=0 \vee \overline{C}=0$$

Since $\frac{1}{\theta}\left[(1-\lambda)\beta B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]\neq 0$, $\overline{v}_2=0 \vee \overline{C}=0$, and since $\overline{C}=0$ does not make any economic nor political sense, $\overline{v}_2=0$.

(3.B.22) $$\dot{K}^{o}(t)=0 \Rightarrow (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\overline{K}^{o}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}-\overline{C}-\delta\overline{K}^{o}=0 \Leftrightarrow \overline{K}^{o}=\frac{1}{\left((1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}-\delta\right)}\overline{C}$$

$$\dot{K}^{u}(t)=0 \Rightarrow (1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\overline{K}^{o}\right)^{\beta}\left(\overline{K}^{u}\right)^{1-\beta}-\delta\overline{K}^{u}=0$$

(3.B.23) $$\Leftrightarrow\left(\overline{K}^{u}\right)=\left[\frac{(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}}{\delta}\right]^{\frac{1}{\beta}}\left(\overline{K}^{o}\right)$$

(3.B.24) $$\dot{v}_2=0 \Rightarrow \left[\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^{o}}{\overline{K}^{u}}\right)^{\beta}\right]=0 \vee \overline{v}_2=0$$

To derive the relative size of the underground economy the expressions for official output $y^{o}(t)$ and underground output $y^{u}(t)$ in equilibrium are obtained first in, respectively, equation (3.B.25) and equation (3.B.26).

(3.B.25) $$\overline{Y}^{o} = \left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}\overline{K}^{o}$$

and

(3.B.26) $$\overline{Y}^{u} = B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\overline{K}^{o}\right)^{\beta}\left(\overline{K}^{u}\right)^{1-\beta}$$

The relative size of the underground economy (RSU_t) as given by the ratio of (3.B.25) and (3.B.26), comes:

(3.B.27) $$RSU_t^C = \left.\frac{\overline{Y}^{u}}{\overline{Y}^{o}}\right|_C = \frac{B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\overline{K}^{o}\right)^{\beta}\left(\overline{K}^{u}\right)^{1-\beta}}{\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}\overline{K}^{o}} = \frac{B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}}{\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}} * \left(\frac{\overline{K}^{u}}{\overline{K}^{o}}\right)^{1-\beta}$$

From (3.B.23) it can be derived that:

$$\left(\frac{\overline{K}^{u}}{\overline{K}^{o}}\right) = \left[\frac{(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}}{\delta}\right]^{\frac{1}{\beta}}$$

, and substituting this into (3.B.27), yields:

$$RSU_t^C = \left.\frac{\overline{Y}^u}{\overline{Y}^o}\right|_C = \frac{B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\overline{K}^o\right)^{\beta}\left(\overline{K}^u\right)^{1-\beta}}{\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}\overline{K}^o}$$

$$= \frac{B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}}{\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}} * \left(\frac{(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}}{\delta}\right)^{\frac{1-\beta}{\beta}} =$$

$$= \underbrace{\overbrace{\left(\frac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}}^{F1}}_{>1} * \underbrace{\overbrace{(1-\lambda)^{\frac{1-\beta}{\beta}}}^{F2}}_{<1} * \overbrace{\frac{1}{\underbrace{B^{\beta}}_{\text{inconclusive}}}}^{F3} * \underbrace{\overbrace{\gamma}^{F4}}_{<1} * \underbrace{\overbrace{\tau}^{F5}}_{<1} * \overbrace{\frac{1}{\underbrace{\overline{\overline{K}}}_{<1}}}^{F6} = \tag{3.B.28}$$

Define ψ as the ratio between this ratio in the centralized equilibrium and in the decentralized macroeconomic equilibrium. If $\psi > 1$ ($\psi < 1$), then the decentralized equilibrium yields a relative smaller (larger) underground economy.

$$\psi=\frac{\left.\dfrac{\overline{Y}^{u}}{\overline{Y}^{o}}\right|_{C}}{\left.\dfrac{\overline{Y}^{u}}{\overline{Y}^{o}}\right|_{D}}=\frac{\left(\dfrac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}*(1-\lambda)^{\frac{1-\beta}{\beta}}*B^{\frac{1}{\beta}}*(\gamma\tau)*\dfrac{1}{\overline{K}}}{\dfrac{(1-\lambda)^{\frac{1-\beta}{\beta}}}{(1-\tau)^{\frac{1-\alpha}{\alpha}}}*\dfrac{B^{\frac{1}{\beta}}}{A^{\frac{1}{\alpha}}}*\gamma*\dfrac{[1-\beta]^{\frac{1-\beta}{\beta}}}{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}*[r+\delta]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}}=$$

$$=\frac{\left(\dfrac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}*\tau*\dfrac{1}{\overline{K}}}{\left(\dfrac{1}{1-\tau}\right)^{\frac{1-\alpha}{\alpha}}*\left(\dfrac{1}{A}\right)^{\frac{1}{\alpha}}*\dfrac{[1-\beta]^{\frac{1-\beta}{\beta}}}{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}*[r+\delta]^{\frac{1-\alpha}{\alpha}-\frac{1-\beta}{\beta}}}=$$

$$=\underbrace{\overbrace{\left(\frac{1}{\delta}\right)^{\frac{1-\beta}{\beta}}}^{F1}}_{>1}*\underbrace{\overbrace{(\tau)}^{F2}}_{<1}*\underbrace{\overbrace{(1-\tau)^{\frac{1-\alpha}{\alpha}}}^{F3}}_{<1}*\overbrace{\underbrace{A^{\frac{1}{\alpha}}}_{\text{inconclusive}}}^{F4}*\underbrace{\overbrace{\frac{[1-\alpha]^{\frac{1-\alpha}{\alpha}}}{[1-\beta]^{\frac{1-\beta}{\beta}}}}^{F5}}_{>1}*\underbrace{\overbrace{[r+\delta]^{\frac{1-\beta}{\beta}-\frac{1-\alpha}{\alpha}}}^{F6}}_{>1}*\underbrace{\overbrace{\frac{1}{\overline{K}}}^{F7}}_{<1}$$

This outcome is further discussed in the main text.

Appendix 3.C. A neoclassical general equilibrium model with underground activities and heterogeneous agents: Decentralized equilibrium

This exercise starts solving the optimization problem for the representative official agent. Next, the analysis proceeds with the optimization problem of the representative underground agent.

Optimization problem for the representative official agent

The problem of the representative official agent is to maximize its utility by choosing $c^o(t)$ subject to its intertemporal budget constraint.

$$\underset{\{c^o\}}{\text{Max}}\, U^o = \int_0^\infty u^o(c)^o e^{-\rho t} dt$$

$$\text{s.t. } \dot{k}^o(t) = (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^\alpha \left(k^o(t)\right)^{1-\alpha} - c^o(t) - \delta k^o(t)$$

$$0 \leq k^o(t) \leq 1$$

The present value Hamiltonian for this optimization problem is:

$$H = \frac{c^o(t)^{1-\theta} - 1}{1-\theta} + m_1\left[(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^\alpha \left(k^o(t)\right)^{1-\alpha} - c^o(t) - \delta k^o(t)\right]$$

where m_1 is the co-state variable associated with the constraint.

The Pontryagin optimality conditions for this optimal control problem are:

Optimality condition

(3.C.1) $c^o(t)^{-\theta} - m_1 = 0 \Leftrightarrow c^o(t)^{-\theta} = m_1$

Admissibility conditions

(3.C.2) $\dot{k}^{o}(t) = (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{1-\alpha} - c^{o}(t) - \delta k^{o}(t)$

(3.C.3) $k^{o}(0) = k_{0}^{o}$

(3.C.4) $0 \le k^{o}(t) \le 1$

Multiplier condition

(3.C.5) $\dot{m}_1 = \rho m_1 - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{-\alpha} m_1 + \delta m_1 = \left[\rho + \delta - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{-\alpha}\right] m_1$

Transversality condition

(3.C.6) $\lim_{t\to\infty} m_1 k^{o}(t) e^{-\rho t} = 0$

Since the Hamiltonian is concave with respect to $c^{o}(t)$ and $k^{o}(t)$, these conditions are necessary and sufficient.

Time-differentiating (3.C.1) yields:

(3.C.7) $-\theta c^{o}(t)^{-\theta-1}\dot{c}^{o}(t) = \dot{m}_1$

and next substituting for m_1 and $\dot{m}_1$ from (3.C.1) and (3.C.5) respectively yields

$$-\theta c^{o}(t)^{-\theta-1}\dot{c}^{o}(t) = \dot{m}_1$$

$$-\theta c^{o}(t)^{-\theta-1}\dot{c}^{o}(t) = \left[\rho + \delta - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{-\alpha}\right] m_1$$

(3.C.8) $-\theta \dot{c}^{o}(t) = \left[\rho + \delta - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{-\alpha}\right] c^{o}(t)$

$$\dot{c}^{o}(t) = -\left[\frac{\rho + \delta - (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^{o}(t)\right)^{-\alpha}}{\theta}\right] c^{o}(t)$$

Consequently the dynamical system is given by:

(3.C.9) $$\dot{c}^o(t) = -\left[\frac{\rho+\delta-(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^o(t)\right)^{-\alpha}}{\theta}\right]c^o(t)$$

(3.C.10) $$\dot{k}^o(t) = (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^o(t)\right)^{1-\alpha} - c^o(t) - \delta k^o(t)$$

In the equilibrium $\dot{c}^o(t) = 0$ and $\dot{k}^o(t) = 0$, so

$$\dot{c}^o(t) = 0 \Rightarrow \left(\rho+\delta-(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(\bar{k}^o\right)^{-\alpha}\right) = 0 \vee \bar{c}^o = 0$$
$$\Leftrightarrow (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(\bar{k}^o\right)^{-\alpha} = \rho+\delta \vee \bar{c}^o = 0$$
$$\Leftrightarrow \bar{k}^o = \left(\frac{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}}{\rho+\delta}\right)^{1/\alpha} = 0 \vee \bar{c}^o = 0$$

$$\dot{k}(t) = 0 \Rightarrow ((1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(\bar{k}^o\right)^{1-\alpha} - \bar{c}^o - \delta\bar{k}^o = 0 \Rightarrow \bar{c}^o = \left[(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(\bar{k}^o\right)^{-\alpha} - \delta\right]\bar{k}^o$$

From $\dot{c}^o(t) = 0 : (1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^o(t)\right)^{-\alpha} = \frac{\rho+\delta}{(1-\alpha)}$, so $\bar{c}^o = \left[\frac{\rho+\delta}{1-\alpha} - \delta\right]\bar{k}^o$.

The dynamics of this system in the neighbourhood of the equilibrium can be characterized through the properties of the Jacobian matrix (J). Determining the partial derivatives and substituting for the equilibrium values, the trace, determinant and roots of the characteristic equation (λ_s and λ_u) can be derived. These describe the economic dynamics.

$$J=\begin{bmatrix}\frac{\partial \dot c^O}{\partial c^O} & \frac{\partial \dot c^O}{\partial k^O}\\ \frac{\partial \dot k^O}{\partial c^O} & \frac{\partial \dot k^O}{\partial k^O}\end{bmatrix}_{\dot c^o(t)=\dot k^o(t)=0} =$$

$$=\begin{bmatrix}-\left[\frac{\rho+\delta-(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^O(t)\right)^{-\alpha}}{\theta}\right] & \frac{-\alpha(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^O(t)\right)^{-\alpha-1}}{\theta}c^O(t)\\ -1 & (1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left(k^O(t)\right)^{-\alpha}-\delta\end{bmatrix}_{\dot c^u(t)=\dot k^u(t)=0} =\begin{bmatrix}0 & -\frac{\alpha(\rho+\delta)}{\theta}\frac{\bar c^O}{\bar k^O}\\ -1 & \rho\end{bmatrix}$$

$$=\begin{bmatrix}0 & -\frac{\alpha(\rho+\delta)}{\theta}\left(\frac{\rho+\delta}{1-\alpha}-\delta\right)\\ -1 & \rho\end{bmatrix}$$

Hence tr(J)=ρ, which is positive and $|J|=0-\underbrace{\frac{\alpha(\rho+\delta)}{\theta}}_{+}*\underbrace{\left(\frac{\rho+\delta}{1-\alpha}-\delta\right)}_{=\frac{\bar c^u}{\bar k^u}=+}<0$. This implies that

$\lambda_s<0$ and $\lambda_u>0$. So the equilibrium is conditionally unstable.

Representative underground agent

The problem of the representative underground agent is to maximize its utility by choosing $c^u(t)$ subject to its intertemporal budget constraint.

$$\max_{\{c^u\}} U^u=\int_0^\infty u^u(c)^u e^{-\rho t}dt$$

$$\text{s.t. } \dot k^u(t)=(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{1-\beta}-c^u(t)-\delta k^u(t)$$

$$0\le k^u(t)\le 1$$

The present value Hamiltonian for this optimization problem is:

$$H=\frac{c^u(t)^{1-\theta}-1}{1-\theta}+m_2\left[(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{1-\beta}-c^u(t)-\delta k^u(t)\right]$$

where m_2 is the co-state variable associated with the constraint.

The Pontryagin optimality conditions for this optimal control problem are:

Optimality condition

(3.C.11) $c^u(t)^{-\theta} - m_2 = 0 \Leftrightarrow c^u(t)^{-\theta} = m_2$

Admissibility conditions

(3.C.12) $\dot{k}^u(t) = (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{1-\beta} - c^u(t) - \delta k^u(t)$

(3.C.13) $k^u(0) = k_0^u$

(3.C.14) $0 \le k^u(t) \le 1$

Multiplier condition

(3.C.15) $\dot{m}_2 = \rho m_2 - (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta} m_2 + \delta m_2 = \left[\rho + \delta - (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta}\right] m_2$

Transversality condition

(3.C.16) $\lim_{t\to\infty} m_2 k^u(t) e^{-\rho t} = 0$

Since the Hamiltonian is concave with respect to $c^u(t)$ and $k^u(t)$, these conditions are necessary and sufficient.

Time-differentiating (3.C.11) yields:

(3.C.17) $-\theta c^u(t)^{-\theta-1}\dot{c}^u(t) = \dot{m}_2$

and next substituting for m_2 and $\dot{m}_2$ from (3.C.11) and (3.C.15) respectively yields

$$-\theta c^u(t)^{-\theta-1}\dot{c}^u(t) = \dot{m}_2$$

$$-\theta c^u(t)^{-\theta-1}\dot{c}^u(t) = \left[\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta}\right]m_2$$

(3.C.18) $$-\theta\dot{c}^u(t) = \left[\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta}\right]c^u(t)$$

$$\dot{c}^u(t) = -\left[\frac{\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta}}{\theta}\right]c^u(t)$$

Consequently the dynamical system is given by:

(3.C.19) $$\dot{c}^u(t) = -\left[\frac{\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta}}{\theta}\right]c^u(t)$$

(3.C.20) $$\dot{k}^u(t) = (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{1-\beta} - c^u(t) - \delta k^u(t)$$

In the equilibrium $\dot{c}^u(t) = 0$ and $\dot{k}^u(t) = 0$, so

$$\dot{c}^u(t) = 0 \Rightarrow \left(\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(\bar{k}^u\right)^{-\beta}\right) = 0 \vee \bar{c}^u = 0$$

$$\Leftrightarrow (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(\bar{k}^u\right)^{-\beta} = \rho+\delta \vee \bar{c}^u = 0$$

$$\Leftrightarrow \bar{k}^u = \left(\frac{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}}{\rho+\delta}\right)^{1/\beta} = 0 \vee \bar{c}^u = 0$$

$$\dot{k}^u(t) = 0 \Rightarrow (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{1-\beta} - c^u(t) - \delta k^u(t) = 0 \Rightarrow \bar{c}^u = \left[(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(\bar{k}^u\right)^{-\beta} - \delta\right]\bar{k}^u$$

From $\dot{c}^u(t) = 0 : (1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(\bar{k}^u\right)^{-\beta} = \frac{\rho+\delta}{1-\beta}$, so $\bar{c}^u = \left[\frac{\rho+\delta}{1-\beta} - \delta\right]\bar{k}^u$

The dynamics of this system in the neighbourhood of the equilibrium can be characterized through the properties of the Jacobian matrix (J). Determining the partial derivatives and substituting for the equilibrium values, the trace, determinant and roots of the characteristic equation (λ_s and λ_u) can be derived. These describe the economic dynamics.

$$J = \begin{bmatrix} \frac{\partial \dot{c}^u}{\partial c^u} & \frac{\partial \dot{c}^u}{\partial k^u} \\ \frac{\partial \dot{k}^u}{\partial c^u} & \frac{\partial \dot{k}^u}{\partial k^u} \end{bmatrix}_{\dot{c}^u(t)=\dot{k}^u(t)=0} =$$

$$= \begin{bmatrix} -\left[\frac{\rho+\delta-(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta}}{\theta}\right] & \frac{-\beta(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta-1}}{\theta} c^u(t) \\ -1 & (1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left(k^u(t)\right)^{-\beta} - \delta \end{bmatrix}_{\dot{c}^u(t)=\dot{k}^u(t)=0}$$

$$= \begin{bmatrix} 0 & \frac{-\beta(\rho+\delta)}{\theta}\frac{\bar{c}^u}{\bar{k}^u} \\ -1 & \rho \end{bmatrix} = \begin{bmatrix} 0 & \frac{-\beta(\rho+\delta)}{\theta}\left(\frac{\rho+\delta}{1-\beta}-\delta\right) \\ -1 & \rho \end{bmatrix}$$

Hence tr(J)=ρ, which is positive, and $|J| = 0 - \underbrace{\frac{\beta(\rho+\delta)}{\theta}}_{+}\underbrace{\left(\frac{\rho+\delta}{1-\beta}-\delta\right)}_{\frac{c^u}{k^u}=+} < 0$. This implies that

$\lambda_s<0$ and $\lambda_u>0$. So the equilibrium is conditionally unstable.

From (3.C.9) and (3.C.19), respectively, in the equilibrium:

(3.C.21) $$\underbrace{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^o(t)^{-\alpha}}_{\text{marginal product of capital in the official sector}} = r+\delta$$

$$(3.C.22)\quad \underbrace{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^{u}(t)^{-\beta}}_{\substack{\text{marginal product of capital}\\ \text{in the underground sector}}} = r+\delta$$

From (3.C.21) and (3.C.22) it may be inferred that in the equilibrium the net marginal product of capital is the same in the official and in the underground sector, and equals the sum of the interest rate and the depreciation rate.

As a matter of fact, this is the only way the economy can be in equilibrium. If these were different, there would be an incentive to shift production from one sector to the other, either way depending on which had a larger marginal product of capital.

To derive the relative size of the underground economy the expressions for official output $y^{o}(t)$ and underground output $y^{u}(t)$ are first obtained in respectively equation (3.C.23) and equation (3.C.24).

$$(3.C.23)\quad y^{o}(t) = A\left(\frac{G(t)}{K(t)}\right)^{\alpha} k^{o}(t)^{1-\alpha} = A\left(\frac{G(t)}{K(t)}\right)^{\alpha}\left[\frac{(1-\alpha)(1-\tau)A\left(\frac{G(t)}{K(t)}\right)^{\alpha}}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}} =$$

$$= A^{\frac{1}{\alpha}} * \left(\frac{G(t)}{K(t)}\right) * \left[\frac{(1-\alpha)(1-\tau)}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}}$$

and

$$y^u(t) = B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta} k^u(t)^{1-\beta} = B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}\left[\frac{(1-\beta)(1-\lambda)B\left(\frac{\gamma G(t)}{K(t)}\right)^{\beta}}{\rho+\delta}\right]^{\frac{1-\beta}{\beta}} = \tag{3.C.24}$$

$$= B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right) * \left[\frac{(1-\beta)(1-\lambda)}{\rho+\delta}\right]^{\frac{1-\beta}{\beta}}$$

So, the relative size of the underground economy (RSU_t) as given by the ratio of (3.C.24) and (3.C.23), comes:

$$RSU_t = \frac{y^u(t)}{y^o(t)} = \frac{B^{\frac{1}{\beta}}\left(\frac{\gamma G(t)}{K(t)}\right)\left[\frac{(1-\lambda)(1-\beta)}{\rho+\delta}\right]^{\frac{1-\beta}{\beta}}}{A^{\frac{1}{\alpha}}\left(\frac{G(t)}{K(t)}\right)\left[\frac{(1-\tau)(1-\alpha)}{\rho+\delta}\right]^{\frac{1-\alpha}{\alpha}}} \tag{3.C.25}$$

This is exactly the same result as obtained with the model developed in Section 3.2.

Appendix 3.D. A neoclassical general equilibrium model with underground activities and heterogeneous agents: centralized equilibrium

The central planner determines the centralized equilibrium by maximizing the sum of well being of all agents in the economy.

(3.D.1) $U = \int_0^\infty U^o(C^o)e^{-\rho t}dt + \int_0^\infty U^u(C^u)e^{-\rho t}dt$

The central planner knows that $G(t)=\tau Y^o(t)$, hence $Y^o(t)$ comes:

(3.D.2)
$$Y^o(t) = A\left(\frac{G(t)}{\overline{K}}\right)^\alpha (K^o(t))^{1-\alpha} = A\left(\frac{\tau Y^o(t)}{\overline{K}}\right)^\alpha (K^o(t))^{1-\alpha} \Rightarrow (Y^o(t))^{1-\alpha} = A(\tau)^\alpha\left(\frac{1}{\overline{K}}\right)^\alpha (K^o(t))^{1-\alpha}$$
$$\Rightarrow Y^o(t) = \left[A(\tau)^\alpha\left(\frac{1}{\overline{K}}\right)^\alpha (K^o(t))^{1-\alpha}\right]^{\frac{1}{1-\alpha}} = \left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}} K^o(t)$$

while $Y^u(t)$ comes:

$$Y^u(t) = B\left(\frac{\gamma G(t)}{K(t)}\right)^\beta \left(K^u(t)\right)^{1-\beta} = B\left(\frac{\gamma G(t)}{\overline{K}}\right)^\beta \left(K^u(t)\right)^{1-\beta} = B\left(\frac{\gamma\tau Y^o(t))}{\overline{K}}\right)^\beta \left(K^u(t)\right)^{1-\beta}$$

(3.D.3)
$$\Rightarrow Y^u(t) = B\left(\frac{\gamma\tau}{\overline{K}}\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}} K^o(t)\right)^\beta \left(K^u(t)\right)^{1-\beta} =$$
$$= B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}} K^o(t)\right)^\beta \left(K^u(t)\right)^{1-\beta}$$
$$= B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{1}{1-\alpha}} K^o(t)\right)^\beta \left(K^u(t)\right)^{1-\beta} = B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}} (K^o(t))^\beta \left(K^u(t)\right)^{1-\beta}$$

This yields for $\dot{K}^{o}(t)$:

(3.D.4) $$\dot{K}^{o}(t) = I^{o}(t) - \delta K^{o}(t) = (1-\tau)Y^{o}(t) - C^{o}(t) - \delta K^{o}(t) = (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}K^{o}(t) - C^{o}(t) - \delta K^{o}(t)$$

and for $\dot{K}^{u}(t)$

$$\dot{K}^{u}(t) = I^{u}(t) - \delta K^{u}(t) = (1-\lambda)Y^{u}(t) - C^{u}(t) - \delta K^{u}(t) =$$

(3.D.5) $$= (1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta} - C^{u}(t) - \delta K^{u}(t)$$

So the central planner's problem resumes to solving the following problem:

$$\underset{\{C^{o},C^{u}\}}{\text{Max}}\ U = \int_0^{\infty} U^{o}(C^{o})e^{-\rho t}dt + \int_0^{\infty} U^{u}(C^{u})e^{-\rho t}dt$$

s.t. $\dot{K}^{o}(t) = (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}K^{o}(t)\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}} - C^{o}(t) - \delta K^{o}(t)$

$$\dot{K}^{u}(t) = (1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta} - C^{u}(t) - \delta K^{u}(t)$$

The present value Hamiltonian for this optimization problem is:

$$H = \frac{C^{o}(t)^{1-\theta}-1}{1-\theta} + \frac{C^{u}(t)^{1-\theta}-1}{1-\theta} + q_1\left[(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}K^{o}(t)\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}} - C^{o}(t) - \delta K^{o}(t)\right] + q_2\left[(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta} - C^{u}(t) - \delta K^{u}(t)\right]$$

where q_1 is the co-state variable associated with constraint (3.D.4) and q_2 the co-state variable associated with constraint (3.D.5).

The Pontryagin optimality conditions for this optimal control problem are:

Optimality condition

(3.D.6) $C^{o}(t)^{-\theta} - q_1 = 0 \Leftrightarrow C^{o}(t)^{-\theta} = q_1$

(3.D.7) $C^{u}(t)^{-\theta} - q_2 = 0 \Leftrightarrow C^{u}(t)^{-\theta} = q_2$

Admissibility conditions

(3.D.8) $\dot{K}^{o}(t)=(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}K^{o}(t)\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}-C^{o}(t)-\delta K^{o}(t)$

(3.D.9) $\dot{K}^{u}(t)=(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta}-C^{u}(t)-\delta K^{u}(t)$

(3.D.10) $K^{o}(0)=K_{0}^{o}$

(3.D.11) $K^{u}(0)=K_{0}^{u}$

(3.D.12) $K(t)=K^{o}(t)+K^{u}(t)=\overline{K}$

Multiplier conditions

(3.D.13)
$$\dot{q}_1=\rho q_1-\frac{\partial H}{\partial K^{o}}=\rho q_1-q_1\left[(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}-\delta\right]-q_2\left[(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\beta\left(K^{o}(t)\right)^{\beta-1}\left(K^{u}(t)\right)^{1-\beta}\right]=$$
$$=\left[\rho+\delta-((1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]q_1-\left[\beta(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta-1}\right]q_2$$

(3.D.14)
$$\dot{q}_2=\rho q_2-\frac{\partial H}{\partial K^{u}}=\rho q_2-q_2\left[(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(K^{o}(t)\right)^{\beta}\left(K^{u}(t)\right)^{-\beta}-\delta\right]=\left[\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta}\right]q_2$$

Transversality conditions

(3.D.15) $\lim_{t\to\infty} q_1 K^{o}(t)e^{-\rho t}=0$

(3.D.16) $\lim_{t\to\infty} q_2 K^{u}(t)e^{-\rho t}=0$

Time-differentiating (3.D.6) and next substituting for $\dot{q}_1$ from (3.D.13) yields

$$-\theta C^o(t)^{-\theta-1}\dot{C}^o(t)=\dot{q}_1$$

$$\Leftrightarrow -\theta C^o(t)^{-\theta-1}\dot{C}^o(t)=\left[\rho+\delta-((1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]q_1-\left[\beta(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta-1}\right]q_2$$

(3.D.17) $$\Leftrightarrow -\theta C^o(t)^{-\theta-1}\dot{C}^o(t)=\left[\rho+\delta-((1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}\right]C^o(t)^{-\theta}-\left[\beta(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta-1}\right]C^u(t)^{-\theta}$$

$$\Rightarrow \dot{C}^o(t)=-\left[\frac{\rho+\delta-((1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right]C^o(t)+\left[\frac{\beta(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta-1}}{\theta}\right]C^o(t)^{1+\theta}C^u(t)^{-\theta}$$

Time-differentiating (3.D.7) and next substituting for $\dot{q}_2$ from (3.D.14) yields

$$-\theta C^u(t)^{-\theta-1}\dot{C}^u(t)=\dot{q}_2$$

$$-\theta C^u(t)^{-\theta-1}\dot{C}^u(t)=\left[\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta}\right]q_2$$

$$-\theta C^u(t)^{-\theta-1}\dot{C}^u(t)=\left[\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta}\right]C^u(t)^{-\theta}$$

$$\dot{C}^u(t)=-\left[\frac{\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta}}{\theta}\right]C^u(t)$$

Consequently the dynamical system is given by:

(3.D.18)
$$\dot{C}^o(t)=-\left[\frac{\rho+\delta-((1-\tau)\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right]C^o(t)+$$
$$+\left[\frac{\beta(1-\lambda)B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^o(t)}{K^u(t)}\right)^{\beta-1}}{\theta}\right]C^o(t)^{1+\theta}C^u(t)^{-\theta}$$

$$\text{(3.D.19)} \quad \dot{C}^u(t) = -\left[\frac{\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{K^{o}(t)}{K^{u}(t)}\right)^{\beta}}{\theta}\right]C^u(t)$$

$$\text{(3.D.20)} \quad \dot{K}^o(t) = (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}K^o(t)\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}} - C^o(t) - \delta K^o(t)$$

$$\text{(3.D.21)} \quad \dot{K}^u(t) = (1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(K^o(t)\right)^{\beta}\left(K^u(t)\right)^{1-\beta} - C^u(t) - \delta K^u(t)$$

As will be proven in the end, there is no underground economic activity in this centralized equilibrium. This is proven by following a contradiction procedure, by assuming in the beginning that there is underground economic activity in this centralized equilibrium, i.e. by assuming that $\overline{Y}^u, \overline{K}^u, \overline{C}^u \neq 0$.

Let's start deriving the marginal products of capital in the official economy and in the underground economy, respectively, in the centralized equilibrium. These will be very useful in the further simplification of the expressions obtained in the solution of the centralized equilibrium:

- Marginal product of capital in the official economy (MPK^O):

$$\text{(3.D.22)} \quad MPK^O = (1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}$$

- Marginal product of capital in the underground economy (MPK^U):

$$\text{(3.D.23)} \quad MPK^U = (1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left[\frac{1}{\overline{K}}\right]^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^o}{\overline{K}^u}\right)^{\beta}$$

In the equilibrium $\dot{C}^o(t) = 0$, $\dot{C}^u(t) = 0$, $\dot{K}^o(t) = 0$ and $\dot{K}^u(t) = 0$, so

$$\dot{C}^o(t) = 0 \Rightarrow -\left[\frac{\rho + \delta - ((1-\tau)[A\tau^\alpha]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right]\overline{C}^o + \left[\frac{\beta(1-\lambda)B\left(\gamma\tau[A\tau^\alpha]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^o}{\overline{K}^u}\right)^{\beta-1}}{\theta}\right](\overline{C}^o)^{1+\theta}(\overline{C}^u)^{-\theta} = 0$$

Let's assume that $\overline{C}^u \neq 0$, then

$$\Rightarrow \left[\frac{\rho + \delta - (1-\tau)[A\tau^\alpha]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right]\overline{C}^o =$$

$$\left[\frac{\beta(1-\lambda)B\left(\gamma\tau[A\tau^\alpha]^{\frac{1}{1-\alpha}}\right)^\beta\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^o}{\overline{K}^u}\right)^{\beta-1}}{\theta}\right](\overline{C}^o)^{1+\theta}(\overline{C}^u)^{-\theta}$$

$$\Leftrightarrow \left(\frac{\overline{C}^o}{\overline{C}^u}\right)^\theta = \left[\frac{\rho + \delta - (1-\tau)[A\tau^\alpha]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\beta(1-\lambda)B\left(\gamma\tau[A\tau^\alpha]^{\frac{1}{1-\alpha}}\right)^\beta\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\beta}{1-\alpha}}}\right]\left(\frac{\overline{K}^o}{\overline{K}^u}\right)^{1-\beta}$$

Substituting for the marginal products in (3.D.22) and (3.D.23) yields:

$$\text{(3.D.24)} \quad \left(\frac{\overline{C}^o}{\overline{C}^u}\right)^\theta = \left[\frac{(1-\beta)(\rho+\delta-MPK^O)}{\beta * MPK^U}\right]\left(\frac{\overline{K}^o}{\overline{K}^u}\right)$$

$$\dot{C}^u(t) = 0 \Rightarrow -\left[\frac{\rho + \delta - (1-\lambda)(1-\beta)B\left(\gamma\tau[A\tau^\alpha]^{\frac{1}{1-\alpha}}\right)^\beta\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^o}{\overline{K}^u}\right)^\beta}{\theta}\right]\overline{C}^u = 0$$

Since we are assuming that $\bar{C}^u \neq 0$, this implies

$$(1-\lambda)(1-\beta)B\left(\gamma\tau[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\right)^{\beta}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\beta}{1-\alpha}}\left(\frac{\bar{K}^{o}}{\bar{K}^{u}}\right)^{\beta}=\rho+\delta$$

Substituting for the marginal product in (3.D.23) yields:

(3.D.25) $\mathrm{MPK}^{U}=\rho+\delta$

So in the centralized equilibrium, the marginal product of capital in the underground economy equals the sum of the cost of capital and its depreciation rate.

$$\dot{K}^{o}(t)=0\Rightarrow\bar{C}^{o}=(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\bar{K}^{o}-\delta\bar{K}^{o}=\left[(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}-\delta\right]\bar{K}^{o}$$

Substituting for the marginal product in (3.D.22)yields:

(3.D.26) $\bar{C}^{o}=[\mathrm{MPK}^{O}-\delta]\bar{K}^{o}$

$$\dot{K}^{u}(t)=0\Rightarrow\bar{C}^{u}=(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\bar{K}^{o}\right)^{\beta}\left(\bar{K}^{u}\right)^{1-\beta}-\delta\bar{K}^{u}$$

Substituting for the marginal product in (3.D.23)yields:

(3.D.27) $\bar{C}^{u}=\left[\frac{\mathrm{MPK}^{u}}{1-\beta}-\delta\right]\bar{K}^{u}$

Combining equations (3.D.26) and (3.D.27) yields:

(3.D.28) $\left(\frac{\bar{C}^{o}}{\bar{C}^{u}}\right)=\frac{[\mathrm{MPK}^{O}-\delta]}{\left[\frac{\mathrm{MPK}^{u}}{1-\beta}-\delta\right]}*\left(\frac{\bar{K}^{o}}{\bar{K}^{u}}\right)$

Equations (3.D.24) and (3.D.28) are used to derive expressions for $\left(\frac{\bar{C}^o}{\bar{C}^u}\right)$ and $\left(\frac{\bar{K}^o}{\bar{K}^u}\right)$:

(3.D.29) $$\left(\frac{\bar{C}^o}{\bar{C}^u}\right) = \left\{\frac{[MPK^O-\delta]}{\left[\frac{MPK^u}{1-\beta}-\delta\right]} * \left[\frac{\beta*MPK^U}{(1-\beta)(\rho+\delta-MPK^O)}\right]\right\}^{\frac{1}{1-\theta}}$$

and

(3.D.30) $$\left[\frac{\bar{K}^o}{\bar{K}^u}\right] = \left\{\frac{[MPK^O-\delta]}{\left[\frac{MPK^u}{1-\beta}-\delta\right]} * \left[\frac{\beta*MPK^U}{(1-\beta)(\rho+\delta-MPK^O)}\right]\right\}^{\frac{1}{1-\theta}} * \frac{\left[\frac{MPK^u}{1-\beta}-\delta\right]}{[MPK^O-\delta]}$$

Substituting for (3.D.25) in (3.D.29) and (3.D.30) yields:

(3.D.31) $$\left[\frac{\bar{C}^o}{\bar{C}^u}\right] = \left\{\frac{[MPK^O-\delta]}{\left[\frac{\rho+\delta}{(1-\beta)}-\delta\right]} * \left[\frac{\beta(\rho+\delta)}{(1-\beta)(\rho+\delta-MPK^O)}\right]\right\}^{\frac{1}{1-\theta}}$$

and

(3.D.32) $$\left[\frac{\bar{K}^o}{\bar{K}^u}\right] = \left\{\frac{[MPK^O-\delta]}{\left[\frac{\rho+\delta}{1-\beta}-\delta\right]} * \left[\frac{\beta(\rho+\delta)}{(1-\beta)(\rho+\delta-MPK^O)}\right]\right\}^{\frac{1}{1-\theta}} * \frac{\left[\frac{\rho+\delta}{1-\beta}-\delta\right]}{[MPK^O-\delta]}$$

The expressions for official output $Y^o(t)$ and underground output $Y^u(t)$ are presented in, respectively, equation (3.D.33) and equation (3.D.34), and used next to derive the relative size of the underground economy in the equilibrium.

(3.D.33) $$y^o(t) = \left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\bar{\bar{K}}}\right]^{\frac{\alpha}{1-\alpha}}\bar{K}^o$$

and

(3.D.34) $$y^u(t) = B\left(\gamma\tau\left[A\tau^\alpha\right]^{\frac{1}{1-\alpha}}\right)^\beta\left(\frac{1}{\bar{\bar{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\bar{K}^o\right)^\beta\left(\bar{K}^u\right)^{1-\beta}$$

$$\text{(3.D.35)}\quad \left.\frac{\overline{Y}^{U}}{\overline{Y}^{O}}\right|_{C} = \frac{[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{R}}\right]^{\frac{\alpha}{1-\alpha}}\overline{K}^{o}}{B\left(\gamma\tau[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\right)^{\beta}\left[\frac{1}{\overline{R}}\right]^{\frac{\beta}{1-\alpha}}\overline{K}^{o\,\beta}\overline{K}^{u\,1-\beta}} = \frac{[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{R}}\right]^{\frac{\alpha}{1-\alpha}}}{B\left(\gamma\tau[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\right)^{\beta}\left[\frac{1}{\overline{R}}\right]^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^{o}(t)}{\overline{K}^{u}(t)}\right)^{\beta}}\left(\frac{\overline{K}^{o}(t)}{\overline{K}^{u}(t)}\right) =$$

$$\frac{[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{R}}\right]^{\frac{\alpha}{1-\alpha}}}{\frac{MPK^{U}}{(1-\lambda)(1-\beta)}}\left(\frac{\overline{K}^{o}(t)}{\overline{K}^{u}(t)}\right) = \frac{(1-\lambda)(1-\beta)[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{R}}\right]^{\frac{\alpha}{1-\alpha}}}{\rho+\delta}\left(\frac{\overline{K}^{o}(t)}{\overline{K}^{u}(t)}\right) =$$

$$\frac{(1-\lambda)(1-\beta)MPK^{O}}{\rho+\delta}\left\{\frac{[MPK^{O}-\delta]}{\left[\frac{\rho+\delta}{1-\beta}-\delta\right]} * \left[\frac{\beta(\rho+\delta)}{(1-\beta)(\rho+\delta-MPK^{O})}\right]\right\}^{\frac{1}{1-\theta}} * \frac{\left[\frac{\rho+\delta}{1-\beta}-\delta\right]}{[MPK^{O}-\delta]} =$$

$$\frac{(1-\lambda)(1-\beta)MPK^{O}}{\rho+\delta}\left\{\frac{[MPK^{O}-\delta]}{\left[\frac{\rho+\delta}{1-\beta}-\delta\right]}\right\}^{\frac{2-\theta}{1-\theta}} * \left\{\left[\frac{\beta(\rho+\delta)}{(1-\beta)(\rho+\delta-MPK^{O})}\right]\right\}^{\frac{1}{1-\theta}}$$

This relation imposes some restrictions on MPK^{O} :

$$\text{If } MPK^{O} = \begin{cases} <\delta & , \left.\frac{\overline{Y}^{U}}{\overline{Y}^{O}}\right|_{C} < 0\text{, which is not valid.} \\ \delta & \left.\frac{\overline{Y}^{U}}{\overline{Y}^{O}}\right|_{C} = 0\text{; This contradicts the initial assumption that } \overline{Y}^{U} > 0 \\ \delta << \rho+\delta & \left.\frac{\overline{Y}^{U}}{\overline{Y}^{O}}\right|_{C} > 0 \\ \rho+\delta & \left.\frac{\overline{Y}^{U}}{\overline{Y}^{O}}\right|_{C} \xrightarrow{\text{yields}} \infty\text{, which implies that there is no official activity} \\ >\rho+\delta & \left.\frac{\overline{Y}^{U}}{\overline{Y}^{O}}\right|_{C} < 0\text{, which is not valid.} \end{cases}$$

Hence, MPK^{O} lies necessarily between δ and $\rho + \delta$ ($\delta < MPK^{O} < \rho + \delta$). Else, there is no underground economic activity, which contradicts the initial assumption that there is underground economic activity in the equilibrium, or there is no official economic activity, which does not make any economic nor political sense. If there were no official economic activity, no taxes would be collected; hence no public policies would be conducted.

So by imposing the existence of underground economic activity in the centralized equilibrium, the marginal product of capital in the official economy is necessarily lower than the sum of the cost of capital and its depreciation rate. This does not make any economic sense. Therefore, it is concluded that central planner will keep an official economy and banish the underground economy completely in the centralized equilibrium the.

Abandoning the assumption that there is underground economic activity in the centralized equilibrium produces the following corner solution:

In the equilibrium $\dot{C}^{o}(t) = 0$, $\dot{C}^{u}(t) = 0$, $\dot{K}^{o}(t) = 0$ and $\dot{K}^{u}(t) = 0$, so

$$\dot{C}^{o}(t) = 0 \Rightarrow -\left[\frac{\rho + \delta - ((1-\tau)[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right]\overline{C}^{o} + \left[\frac{\beta(1-\lambda)B\left(\gamma\tau[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{\overline{K}}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^{o}}{\overline{K}^{u}}\right)^{\beta-1}}{\theta}\right]\left(\overline{C}^{o}\right)^{1+\theta}\left(\overline{C}^{u}\right)^{-\theta} = 0$$

If $\overline{C}^{u} = 0$, then

$$\dot{C}^{o}(t) = 0 \Rightarrow \left[\frac{\rho + \delta - (1-\tau)[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right]\overline{C}^{o} + 0 = 0$$

$$\Leftrightarrow \left[\frac{\rho + \delta - (1-\tau)[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}}}{\theta}\right] = 0 \text{ or } \overline{C}^{o} = 0$$

Since $\overline{C}^{o} = 0$, does not make any economic nor political sense, in the equilibruim

$$(1-\tau)[A\tau^{\alpha}]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{\overline{K}}}\right]^{\frac{\alpha}{1-\alpha}} = \rho + \delta$$

So in the centralized equilibrium, the marginal product of capital in the official economy equals the sum of the cost of capital and its depreciation rate.

$$\dot{C}^{u}(t)=0 \Rightarrow -\left[\frac{\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^{o}}{\overline{K}^{u}}\right)^{\beta}}{\theta}\right]\overline{C}^{u}=0$$

$$\Leftrightarrow -\left[\frac{\rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^{o}}{\overline{K}^{u}}\right)^{\beta}}{\theta}\right]=0 \vee \overline{C}^{u}=0$$

$$\Leftrightarrow \rho+\delta-(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\frac{\overline{K}^{o}}{\overline{K}^{u}}\right)^{\beta}=0 \vee \overline{C}^{u}=0$$

$$\Leftrightarrow \left(\frac{\overline{K}^{o}}{\overline{K}^{u}}\right)^{\beta}=\frac{\rho+\delta}{(1-\lambda)(1-\beta)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}} \vee \overline{C}^{u}=0$$

$$\dot{K}^{o}(t)=0 \Rightarrow \overline{C}^{o}=(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}\overline{K}^{o}-\delta\overline{K}^{o}=\left[(1-\tau)\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\left[\frac{1}{\overline{K}}\right]^{\frac{\alpha}{1-\alpha}}-\delta\right]\overline{K}^{o}$$

$$\dot{K}^{u}(t)=0 \Rightarrow \overline{C}^{u}=(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\overline{K}^{o}\right)^{\beta}\left(\overline{K}^{u}\right)^{1-\beta}-\delta\overline{K}^{u}$$

From the above, $\overline{C}^{u}=(1-\lambda)B\left(\gamma\tau\left[A\tau^{\alpha}\right]^{\frac{1}{1-\alpha}}\right)^{\beta}\left(\frac{1}{\overline{K}}\right)^{\frac{\beta}{1-\alpha}}\left(\overline{K}^{o}\right)^{\beta}\left(\overline{K}^{u}\right)^{1-\beta}-\delta\overline{K}^{u}=0 \Rightarrow \overline{K}^{u}=0.$

The expressions for official output $Y^{o}(t)$ and underground output $Y^{u}(t)$ are presented in, respectively, equation (3.D.33) and equation (3.D.34), and used next to derive the relative size of the underground economy.

Since no inputs are devoted to underground activities in the centralized equilibrium, there is no underground activity in the centralized economy. Consequently, the relative size of the underground economy (RSU_t), given by the ratio of (3.D.33) and (3.D.34), equals zero.

Define ψ as the ratio between this ratio in the centralized equilibrium and in the decentralized macroeconomic equilibrium. If $\psi > 1$ ($\psi < 1$), then the decentralized equilibrium yields a relative smaller (larger) underground economy.

$$\psi = \frac{\left.\frac{\bar{Y}^u}{\bar{Y}^o}\right|_C}{\left.\frac{\bar{Y}^u}{\bar{Y}^o}\right|_D} = \frac{0}{\frac{(1-\lambda)^{\frac{1-\beta}{\beta}}}{(1-\tau)^{\frac{1-\alpha}{\alpha}}} * \frac{B^{\frac{1}{\beta}}}{A^{\frac{1}{\alpha}}} * \gamma * \frac{(1-\beta)^{\frac{1-\beta}{\beta}}}{(1-\alpha)^{\frac{1-\alpha}{\alpha}}} * (\rho+\delta)^{\frac{1-\alpha}{\alpha} - \frac{1-\beta}{\beta}}} = 0$$

APPENDICES CHAPTER 4

Appendix 4.A. Data

The data used in this chapter and its sources are described in this Appendix. The data refer to a set of developed[20] and developing[21] countries. Different data sources are used for the developed world and the developing world, respectively. This is mentioned explicitly, where applicable.

Official economic activity

The official economic activity is measured by the Gross Domestic Product (GDP) series and represented by Y^o. The GDP figures usually include an estimate for unrecorded economic activities, in accordance with the OECD handbook (2002). So, the official figures should contain an observed component and an imputed unobserved component. The observed component represents the economic activity that is reported to the statistical authority, namely the activities that are captured by the data collection system used for the compilation of national accounts. The unobserved component is the economic activity which is not captured by the data collection system, including underground activity, and must therefore be imputed.

For the purpose of this research, the whole GDP is assumed to represent official economic activity.

[20] The countries considered in the sample are: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

[21] The countries considered in the sample are:Algeria, Argentina, Bangladesh, Bolivia, Brazil, Cameroon, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Iran, Israel, Jamaica, Jordan, Kenya, Madagascar, Malaysia, Mexico, Morocco, Nicaragua, Pakistan, Panama, Paraguay, Peru, Philippines, Singapore, South Africa, Tunisia and Turkey.

The data for the developed world is obtained from the AMECO database: the GDP series at constant 2000 prices. AMECO is the annual macro-economic database of the Directorate General for Economic and Financial Affairs of the European Commisssion. It covers the European Union countries and some developed countries. This series is reported in the table in Appendix 4.B and covers the time span of the underground economy estimates by Schneider and Buehn (2009).

For the developing world the data is obtained from the United Nations Statistics Division. The United Nations Statistics Division reports the GDP series at constant 1990 prices. This series is presented in the table in Appendix 4.C.

Underground economic activity

As defined in Chapter 2, the underground economy comprises activities that contribute to value added but that are not fully included in the official statistics. These activities are deliberately concealed from the authorities in an attempt to evade taxes and social security contributions, or in an attempt to avoid the detection of other infringements. This definition closely follows Schneider and Buehn (2009).

The estimates of the underground sector as reported in Schneider and Buehn (2009) are used for this purpose. Schneider and Buehn (2009) report percentage point estimates of the underground economy for the developed world for the years 1996, 1998, 2000, 2002, 2003, 2004, 2005 and 2006. For the developing world the figures refer to the years 1999, 2000, 2001, 2002, 2003, 2004, 2005 and 2006. These percentage estimates are applied to the GDP series to obtain absolute estimates of the underground economic activity at constant 2000 prices and constant 1990 prices for the developed and the developing world, respectively.

The series as a percentage of GDP and in absolute values are reported in the tables in Appendices 4.D and 4.E for the developed world and the developing world, respectively.

Stock of capital

The stock of capital refers to the net physical stock of capital. The stock of capital series at constant 2000 prices provided by the AMECO database is used for the developed world. This series is reported in the table in Appendix 4.F.

The estimates provided by Nehru et al (1993) are used for the developing world. However, Nehru et al (1993) cover only the period up to 1990 and at constant 1987 prices. Therefore it was necessary to extend the series up to 2006 with own calculations. The fixed capital formation data as provided by the United Nations Statistics Division was used for this purpose. This data is reported at 1990 prices. The base year of the series provided by Nehru et al (1993) was, therefore, first converted to 1990. This stock of capital series and the fixed capital formation data used to extend the series up to 2006 are reported in the table in Appendix 4.G.

Public expenditures

The public expenditures series refers to final public consumption excluding interest at constant prices. The AMECO database does not report this series at constant prices. So it was necessary to calculate it. This is done for the developed world, by first expressing the public expenditures excluding interest as a percentage of GDP, using both series in current prices from the AMECO database. Next, this percentage is applied to the GDP series at constant 2000 prices from the AMECO database to obtain the public expenditures series at constant 2000 prices. The percentage public expenditures series and the calculated public expenditures series, at constant 2000 prices, are reported in the table in Appendix 4.H.

For the developing world the public expenditures series refers to final public consumption including interest at constant prices, because the United Nations Statistics Division does not report data on public expenditures excluding interest expenses. This series is constructed by applying the percentage of public expenditures to GDP, as reported by the United Nations Statistics Division, to the GDP series at constant 1990 prices. The percentage public expenditures series and the calculated public expenditures series, at constant 1990 prices, are reported in the table in Appendix 4.I.

Tax burden

This variable is proxied by the tax-to-output ratio. The tax-to-output ratio is calculated in two steps for the developed world. First, the annual tax-to-output ratio is derived by taking the ratio of the total tax burden series, including imputed social security contributions, with respect to the GDP series. Both series are expressed in current prices and extracted from the AMECO database. Next, the time average per country is calculated. These series and the tax-to-output ratio are reported in the table in Appendix 4.J.

For the developing countries, the tax burden, proxied by the tax-to-output ratio, is based on estimates from the Heritage Foundation.This series is reported in the table in Appendix 4.K.

Appendix 4.B. GDP series of the developed countries, at constant 2000 prices (Y°)

Country	Unit	1996	1998	2000	2002	2003	2004	2005	2006
Austria	Mrd EURO-ATS	183.1	193.7	207.5	212.0	213.7	219.2	224.6	232.3
Belgium	Mrd EURO-BEF	222.2	234.9	252.2	257.7	259.7	268.1	272.8	280.4
Canada	Mrd CAD	893.5	969.4	1,076.6	1,127.8	1,149.0	1,184.9	1,219.0	1,256.9
Denmark	Mrd DKK	1,155.9	1,218.7	1,294.0	1,309.2	1,314.2	1,344.4	1,377.2	1,423.3
Finland	Mrd EURO-FIM	108.4	121.1	132.2	137.9	140.4	145.6	149.6	157.0
France	Mrd EURO-FRF	1,269.0	1,342.8	1,441.4	1,483.2	1,499.3	1,536.3	1,565.5	1,600.2
Germany	Mrd EURO-DEM	1,886.0	1,959.0	2,062.5	2,088.1	2,083.5	2,108.7	2,124.6	2,191.8
Greece	Mrd EURO-GRD	117.7	126.1	136.3	146.9	155.6	162.8	166.5	174.0
Ireland	Mrd EURO-IEP	71.6	86.6	104.8	118.0	123.2	128.9	136.8	144.2
Italy	Mrd EURO-ITL	1,095.9	1,132.1	1,191.1	1,218.2	1,218.0	1,236.7	1,244.8	1,270.1
Japan	100 Mrd JPY	4,922.4	4,896.9	5,029.9	5,052.4	5,123.8	5,264.4	5,366.2	5,475.7
Luxembourg	Mrd EURO-LUF	16.6	18.7	22.0	23.5	23.8	24.9	26.2	27.7
Netherlands	Mrd EURO-NLG	354.5	384.1	418.0	426.3	427.8	437.3	446.3	461.4
Norway	Mrd NOK	1,299.3	1,406.1	1,481.2	1,533.4	1,549.0	1,608.8	1,652.9	1,690.6
Portugal	Mrd EURO-PTE	103.7	113.3	122.3	125.7	124.7	126.6	127.7	129.5
Spain	Mrd EURO-ESP	527.9	572.8	630.3	670.9	691.7	714.3	740.1	769.9
Sweden	Mrd SEK	1,937.1	2,060.5	2,250.0	2,328.6	2,373.2	2,471.1	2,552.6	2,661.0
Switzerland	Mrd CHF	383.9	402.2	422.1	428.8	428.0	438.8	450.4	466.7
United Kingdom	Mrd GBP	848.5	908.2	976.5	1,021.6	1,050.2	1,081.2	1,104.7	1,136.2
United States	Mrd USD	8,304.8	9,061.0	9,898.8	10,189.9	10,444.9	10,819.3	11,150.4	11,448.5

Source: AMECO database.

Appendix 4.C. GDP series of the developing countries, at constant 1990 prices (Y^o)

		GDP series of the developing countries, at constant 1990 prices							
Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006
Algeria	Mrd USD	71.6	73.1	75.0	78.6	84.0	88.4	92.9	94.5
Argentina	Mrd USD	215.5	213.8	204.3	182.1	198.2	216.1	235.9	255.9
Bangladesh	Mrd USD	42.1	44.6	47.0	49.1	51.6	54.9	58.2	62.0
Bolivia	Mrd USD	6.9	7.0	7.2	7.3	7.5	7.9	8.2	8.6
Brazil	Mrd USD	586.7	611.9	620.0	636.5	643.8	680.5	702.0	729.9
Cameroon	Mrd USD	13.4	14.0	14.6	15.2	15.8	16.4	16.8	17.3
Chile	Mrd USD	59.6	62.3	64.4	65.8	68.4	72.5	76.5	79.9
China	Mrd USD	1,006.1	1,090.6	1,181.2	1,288.8	1,417.7	1,560.9	1,723.3	1,923.3
Colombia	Mrd USD	67.7	69.6	71.2	72.9	76.3	79.8	84.4	90.2
CostaRica	Mrd USD	11.8	12.0	12.2	12.5	13.3	13.9	14.7	16.0
Coted'Ivoire	Mrd USD	15.6	15.2	15.2	14.9	14.7	14.9	15.2	15.4
Dom. Republic	Mrd USD	16.0	16.9	17.2	18.2	18.1	18.4	20.1	22.2
Ecuador	Mrd USD	13.6	13.9	14.7	15.3	15.9	17.1	18.1	18.9
Egypt	Mrd USD	60.7	62.8	64.8	67.5	70.3	73.4	78.5	84.0
El Salvador	Mrd USD	7.4	7.5	7.7	7.8	8.0	8.2	8.4	8.8
Ghana	Mrd USD	9.1	9.5	9.9	10.3	10.9	11.5	12.2	12.9
Guatemala	Mrd USD	9.9	10.2	10.4	10.9	11.1	11.5	11.8	12.5
Honduras	Mrd USD	4.8	5.0	5.2	5.4	5.6	5.9	6.3	6.7
India	Mrd USD	535.1	556.7	585.7	607.8	658.7	713.3	779.9	855.3
Indonesia	Mrd USD	181.2	190.1	197.0	205.9	215.7	226.6	239.4	252.6
Iran	Mrd USD	129.0	132.6	137.7	147.6	157.8	164.8	172.8	183.5
Israel	Mrd USD	93.3	101.6	101.2	100.6	102.4	107.5	113.0	118.9
Jamaica	Mrd USD	5.5	5.5	5.6	5.6	5.8	5.9	6.0	6.1

Source: United Nations Statistics Division.

Appendix 4.C. GDP series of the developing countries, at constant 1990 prices (Y^o) *(continued)*

		GDP series of the developing countries, at constant 1990 prices							
Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006
Jordan	Mrd USD	6.1	6.4	6.7	7.1	7.4	8.0	8.7	9.4
Kenya	Mrd USD	13.2	13.2	13.8	13.9	14.3	15.0	15.9	16.9
Madagascar	Mrd USD	3.5	3.7	3.9	3.4	3.7	3.9	4.1	4.3
Malaysia	Mrd USD	83.4	90.8	91.3	96.2	101.8	108.7	114.5	121.1
Mexico	Mrd USD	380.2	405.2	405.1	408.2	413.9	430.5	444.3	465.7
Morocco	Mrd USD	35.9	36.5	39.2	40.5	43.1	45.2	46.5	50.1
Nicaragua	Mrd USD	4.0	4.2	4.2	4.3	4.5	4.7	4.9	5.1
Pakistan	Mrd USD	79.8	81.4	84.0	88.0	94.5	101.8	108.1	114.6
Panama	Mrd USD	9.7	10.0	10.0	10.2	10.7	11.5	12.3	13.3
Paraguay	Mrd USD	5.6	5.4	5.6	5.6	5.8	6.0	6.2	6.4
Peru	Mrd USD	42.2	43.5	43.6	45.8	47.6	50.0	53.4	57.5
Philippines	Mrd USD	56.5	59.8	60.9	63.6	66.7	71.0	74.5	78.5
Singapore	Mrd USD	70.4	77.4	75.6	78.7	81.7	89.3	95.8	103.8
South Africa	Mrd USD	128.8	134.2	137.8	142.9	147.3	154.5	162.2	170.8
Tunisia	Mrd USD	18.7	19.6	20.5	20.9	22.1	23.4	24.3	25.7
Turkey	Mrd USD	271.9	290.3	273.8	290.7	306.0	334.6	362.7	387.8

Source: United Nations Statistics Division.

Appendix 4.D. Underground economy of the developed countries as a percentage of GDP ($Y^{u}\%$) and at constant 2000 prices (Y^{u})

Country	Unit	1996	1998	2000	2002	2003	2004	2005	2006	Unit	1996	1998	2000	2002	2003	2004	2005	2006
Austria	% of GDP	10.8	11.5	11.7	12.0	12.3	12.4	12.8	13.0	Mrd EURO-ATS	13.6	14.3	15.2	15.0	14.7	14.7	17.0	17.4
Belgium	% of GDP	7.4	7.8	8.3	8.2	8.0	8.0	9.3	9.5	Mrd EURO-BEF	39.8	40.0	40.9	41.8	42.0	42.2	43.5	44.2
Canada	% of GDP	17.9	18.0	18.4	18.8	18.9	19.0	19.6	19.9	Mrd CAD	105.4	112.6	114.4	117.9	117.0	118.8	126.0	126.0
Denmark	% of GDP	11.8	12.6	12.8	13.2	13.1	13.3	14.1	14.1	Mrd DKK	167.6	176.9	176.9	186.1	187.3	187.3	186.1	190.7
Finland	% of GDP	14.5	15.3	15.3	16.1	16.2	16.2	16.1	16.5	Mrd EURO-FIM	15.0	15.7	16.0	16.7	16.8	16.7	17.1	17.1
France	% of GDP	13.8	14.5	14.8	15.4	15.5	15.4	15.8	15.8	Mrd EURO-FRF	148.5	154.8	149.7	153.5	158.6	158.6	167.5	167.5
Germany	% of GDP	11.7	12.2	11.8	12.1	12.5	12.5	13.2	13.2	Mrd EURO-DEM	254.6	264.0	277.2	279.1	277.2	275.3	288.6	290.4
Greece	% of GDP	13.5	14.0	14.7	14.8	14.7	14.6	15.3	15.4	Mrd EURO-GRD	29.0	28.7	29.3	30.0	30.3	29.7	31.0	30.6
Ireland	% of GDP	24.6	24.4	24.9	25.5	25.7	25.2	26.3	26.0	Mrd EURO-IEP	8.7	9.3	9.5	9.7	9.6	9.5	10.1	10.4
Italy	% of GDP	12.1	12.8	13.0	13.5	13.4	13.7	14.1	14.1	Mrd EURO-ITL	232.3	240.0	242.2	244.4	247.7	248.8	254.2	253.2
Japan	% of GDP	12.1	13	13.3	13.5	13.4	13.3	14.1	14.5	100 Mrd JPY	364.3	369.2	388.9	354.4	374.1	388.9	433.2	438.1
Luxembourg	% of GDP	21.2	21.9	22.1	22.3	22.6	22.7	23.2	23.1	Mrd EURO-LUF	1.2	1.3	1.4	1.4	1.4	1.4	1.5	1.6
Netherlands	% of GDP	7.4	7.5	7.9	7.2	7.6	7.9	8.8	8.9	Mrd EURO-NLG	34.4	36.5	37.9	37.6	36.9	36.9	39.3	39.7
Norway	% of GDP	26.1	25.6	26.2	26.7	26.5	26.6	27.5	27.3	Mrd NOK	201.4	210.5	200.1	202.7	206.6	209.2	218.3	215.7
Portugal	% of GDP	7.5	7.9	8.5	8.7	8.6	8.6	9.3	9.4	Mrd EURO-PTE	19.7	20.2	19.7	20.6	20.3	20.2	21.2	21.1
Spain	% of GDP	31.9	31.1	30.9	31.6	31.3	31.6	31.7	32.1	Mrd EURO-ESP	98.2	102.4	104.0	104.5	104.0	104.5	108.2	106.6
Sweden	% of GDP	9.7	10.3	10.7	10.6	10.4	10.4	11.1	11.2	Mrd SEK	286.7	290.6	296.4	302.2	304.1	306.1	315.8	315.8
Switzerland	% of GDP	9.9	11.0	9.8	9.9	10.3	10.4	10.9	10.9	Mrd CHF	27.6	31.1	32.2	31.9	31.1	29.9	32.6	31.9
United Kingdom	% of GDP	15.5	16.2	15.4	15.6	15.9	16.1	16.8	16.6	Mrd GBP	78.1	86.5	82.3	81.5	81.5	84.9	87.4	92.5
United States	% of GDP	19.0	19.5	19.0	19.9	19.6	19.5	20.4	20.3	Mrd USD	490.0	564.7	573.0	548.1	564.7	581.3	656.1	664.4
Time average	% of GDP	18.6	19.4	19.7	19.8	19.7	19.8	20.5	20.2									

Source: Schneider and Buehn (2009) and own calculations.

Appendix 4.E. Underground economy of the developing countries as a percentage of GDP ($Y^{u}\%$) and at constant 1990 prices (Y^{u})

Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006	Unit	1999	2000	2001	2002	2003	2004	2005	2006
Algeria	% of GDP	33.5	34.1	33.9	34.1	34.6	35.0	35.6	35.8	Mrd USD	24.0	24.9	25.4	26.8	29.1	30.9	33.1	33.8
Argentina	% of GDP	25.4	25.4	25.1	25.3	25.4	25.6	26.0	n.a.	Mrd USD	54.7	54.3	51.3	46.1	50.3	55.3	61.3	n.a.
Bangladesh	% of GDP	n.a.	35.6	35.4	35.2	35.0	35.2	35.4	n.a.	Mrd USD	n.a.	15.9	16.6	17.3	18.1	19.3	20.6	n.a.
Bolivia	% of GDP	67.1	67.1	67.1	67.1	67.1	67.2	67.7	68.1	Mrd USD	4.6	4.7	4.8	4.9	5.1	5.3	5.6	5.9
Brazil	% of GDP	39.6	39.8	39.9	39.8	39.7	39.9	40.0	n.a.	Mrd USD	232.3	243.6	247.4	253.3	255.6	271.5	280.8	n.a.
Cameroon	% of GDP	32.4	32.8	32.6	32.7	32.7	32.9	33.3	n.a.	Mrd USD	4.4	4.6	4.8	5.0	5.2	5.4	5.6	n.a.
Chile	% of GDP	19.8	19.8	19.8	19.6	19.9	19.9	20.3	20.5	Mrd USD	11.8	12.3	12.8	12.9	13.6	14.4	15.5	16.4
China	% of GDP	13.0	13.1	13.0	12.9	13.1	13.4	13.6	13.9	Mrd USD	130.8	142.9	153.6	166.3	185.7	209.2	234.4	267.3
Colombia	% of GDP	38.8	39.1	39.2	39.1	39.2	39.7	39.9	40.5	Mrd USD	26.2	27.2	27.9	28.5	29.9	31.7	33.7	36.5
CostaRica	% of GDP	26.4	26.2	25.8	25.8	25.9	26.1	26.4	26.9	Mrd USD	3.1	3.2	3.1	3.2	3.5	3.6	3.9	4.3
Coted'Ivoire	% of GDP	43.6	43.2	43.3	43.3	43.2	43.3	43.4	43.5	Mrd USD	6.8	6.5	6.6	6.5	6.3	6.5	6.6	6.7
Dom. Republic	% of GDP	32.0	32.1	31.8	32.0	32.0	32.3	32.4	32.7	Mrd USD	5.1	5.4	5.5	5.8	5.8	5.9	6.5	7.3
Ecuador	% of GDP	33.4	34.4	34.0	34.2	34.1	34.5	34.9	n.a.	Mrd USD	4.5	4.8	5.0	5.2	5.4	5.9	6.3	n.a.
Egypt	% of GDP	35.1	35.1	35.1	34.8	34.9	34.9	35.2	35.4	Mrd USD	21.3	22.0	22.7	23.5	24.5	25.6	27.6	29.7
El Salvador	% of GDP	46.3	46.3	46.4	46.4	46.5	46.5	46.6	46.7	Mrd USD	3.4	3.5	3.6	3.6	3.7	3.8	3.9	4.1
Ghana	% of GDP	41.5	41.9	42.4	42.1	42.0	42.1	42.3	n.a.	Mrd USD	3.8	4.0	4.2	4.3	4.6	4.8	5.1	n.a.
Guatemala	% of GDP	51.6	51.5	51.1	51.1	51.3	51.4	51.7	51.8	Mrd USD	5.1	5.3	5.3	5.5	5.7	5.9	6.1	6.5
Honduras	% of GDP	49.5	49.6	49.5	49.4	49.4	49.6	49.6	n.a.	Mrd USD	2.4	2.5	2.6	2.6	2.8	3.0	3.1	n.a.
India	% of GDP	23.1	23.1	23.3	23.5	23.7	24.0	24.4	24.6	Mrd USD	123.6	128.6	136.5	142.8	156.1	171.2	190.3	210.4
Indonesia	% of GDP	19.3	19.4	19.2	19.0	18.9	18.6	19.5	n.a.	Mrd USD	35.0	36.9	37.8	39.1	40.8	42.1	46.7	n.a.
Iran	% of GDP	19.2	18.9	18.9	19.3	19.6	19.7	19.6	19.6	Mrd USD	24.8	25.1	26.0	28.5	30.9	32.5	33.9	36.0
Israel	% of GDP	22.0	21.9	21.9	21.7	21.8	22.3	22.8	22.8	Mrd USD	20.5	22.3	22.2	21.8	22.3	24.0	25.8	27.1
Jamaica	% of GDP	36.5	36.4	36.6	36.7	36.7	36.8	37.4	37.0	Mrd USD	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3
Jordan	% of GDP	n.a.	n.a.	20.5	20.6	20.8	21.3	21.8	21.5	Mrd USD	n.a.	n.a.	1.4	1.5	1.5	1.7	1.9	2.0

Source: Schneider and Buehn (2009) and own calculations.

Appendix 4.E. Underground economy of the developing countries as a percentage of GDP (Y^u%) and at constant 1990 prices (Y^u) *(continued)*

Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006	Unit	1999	2000	2001	2002	2003	2004	2005	2006
Kenya	% of GDP	33.9	34.3	34.4	34.0	33.6	34.0	34.3	34.7	Mrd USD	4.5	4.5	4.8	4.7	4.8	5.1	5.5	5.9
Madagascar	% of GDP	n.a.	39.6	39.8	39.1	39.6	40.2	41.0	n.a.	Mrd USD	n.a.	1.4	1.5	1.3	1.5	1.6	1.7	n.a.
Malaysia	% of GDP	30.9	31.1	30.7	30.7	30.7	30.9	31.1	n.a.	Mrd USD	25.8	28.2	28.0	29.5	31.2	33.6	35.6	n.a.
Mexico	% of GDP	30.0	30.1	30.2	30.2	30.7	30.8	31.1	n.a.	Mrd USD	114.1	122.0	122.3	123.3	127.1	132.6	138.2	n.a.
Morocco	% of GDP	36.2	36.4	36.5	36.7	36.9	36.8	36.8	n.a.	Mrd USD	13.0	13.3	14.3	14.9	15.9	16.6	17.1	n.a.
Nicaragua	% of GDP	44.9	45.2	45.2	45.2	45.3	45.4	45.4	45.5	Mrd USD	1.8	1.9	1.9	1.9	2.0	2.1	2.2	2.3
Pakistan	% of GDP	36.7	36.8	36.9	36.9	37.1	37.4	37.7	37.6	Mrd USD	29.3	29.9	31.0	32.5	35.1	38.1	40.7	43.1
Panama	% of GDP	63.9	64.1	63.9	63.9	64.2	64.7	65.1	n.a.	Mrd USD	6.2	6.4	6.4	6.5	6.8	7.4	8.0	n.a.
Paraguay	% of GDP	27.2	27.4	27.7	27.4	27.7	28.0	28.1	28.6	Mrd USD	1.5	1.5	1.5	1.5	1.6	1.7	1.7	1.8
Peru	% of GDP	59.7	59.9	59.7	60.0	59.9	60.1	60.4	60.6	Mrd USD	25.2	26.1	26.0	27.5	28.5	30.0	32.3	34.9
Philippines	% of GDP	43.2	43.3	43.4	43.6	43.9	44.1	44.5	44.9	Mrd USD	24.4	25.9	26.4	27.7	29.3	31.3	33.1	35.3
Singapore	% of GDP	13.2	13.1	12.9	12.9	13.2	13.7	13.9	14.0	Mrd USD	9.3	10.1	9.8	10.2	10.8	12.2	13.3	14.5
South Africa	% of GDP	44.6	44.6	44.6	44.3	44.6	44.6	44.8	44.5	Mrd USD	57.4	59.8	61.5	63.3	65.7	68.9	72.7	76.0
Tunisia	% of GDP	38.3	38.4	38.4	38.5	38.6	39.0	39.1	39.5	Mrd USD	7.2	7.5	7.9	8.0	8.5	9.1	9.5	10.1
Turkey	% of GDP	33.8	33.8	33.2	33.5	33.8	34.0	34.3	34.6	Mrd USD	91.9	98.1	90.9	97.4	103.4	113.8	124.4	134.2
Time average	% of GDP	33.0	35.0	35.5	35.5	35.6	35.8	36.1	23.7	Mrd USD	1,161.7	1,239.1	1,263.2	1,307.5	1,380.9	1,485.9	1,596.6	1,054.3

Source: Schneider and Buehn (2009) and own calculations.

Appendix 4.F. Stock of capital series of the developed countries, at constant 2000 prices (K)

Country	Unit	1996	1998	2000	2002	2003	2004	2005	2006
Austria	Mrd EURO-ATS	604.6	638.8	674.2	704.1	719.0	733.5	747.9	762.7
Belgium	Mrd EURO-BEF	617.4	645.1	674.9	698.7	707.6	719.7	735.3	752.7
Canada	Mrd CAD	2,382.8	2,502.3	2,637.5	2,773.7	2,847.8	2,937.6	3,045.9	3,170.8
Denmark	Mrd DKK	2,696.1	2,795.0	2,897.3	2,989.6	3,026.6	3,067.3	3,119.3	3,203.6
Finland	Mrd EURO-FIM	325.3	331.9	341.6	352.0	357.0	362.5	368.4	375.2
France	Mrd EURO-FRF	3,937.5	4,083.3	4,277.4	4,469.8	4,562.3	4,661.1	4,768.8	4,884.9
Germany	Mrd EURO-DEM	5,828.8	6,068.6	6,334.2	6,514.0	6,579.7	6,640.2	6,695.9	6,777.2
Greece	Mrd EURO-GRD	456.9	475.2	501.3	532.2	549.8	567.0	581.7	599.2
Ireland	Mrd EURO-IEP	215.5	235.8	262.8	289.4	304.2	321.4	341.9	364.0
Italy	Mrd EURO-ITL	3,176.9	3,280.7	3,406.8	3,549.1	3,615.2	3,683.2	3,749.6	3,819.9
Japan	100 Mrd JPY	15,547.1	16,303.4	16,876.2	17,261.5	17,362.4	17,447.8	17,580.9	17,709.8
Luxembourg	Mrd EURO-LUF	31.7	34.5	38.4	42.8	45.5	48.1	50.8	53.5
Netherlands	Mrd EURO-NLG	1,027.0	1,083.2	1,146.6	1,196.6	1,216.5	1,233.9	1,253.2	1,278.0
Norway	Mrd NOK	3,524.8	3,724.9	3,886.7	4,004.4	4,056.0	4,130.1	4,237.4	4,377.1
Portugal	Mrd EURO-PTE	255.8	279.2	306.9	331.8	340.4	348.6	356.1	363.1
Spain	Mrd EURO-ESP	1,565.3	1,675.2	1,822.7	1,985.0	2,072.8	2,165.0	2,265.9	2,376.5
Sweden	Mrd SEK	6,595.4	6,772.9	6,996.2	7,181.2	7,268.7	7,373.2	7,505.9	7,668.5
Switzerland	Mrd CHF	1,328.6	1,368.0	1,409.5	1,438.2	1,448.2	1,461.2	1,476.2	1,494.3
United Kingdom	Mrd GBP	2,203.8	2,304.9	2,417.4	2,531.0	2,589.9	2,651.3	2,717.0	2,789.1
United States	Mrd USD	19,311.7	20,656.4	22,305.3	23,742.3	24,437.4	25,225.2	26,090.7	26,965.6

Source: AMECO database.

Appendix 4.G. Stock of capital series of the developing countries, at constant 1990 prices (K)

		Stock of capital, at constant 1990 prices								Fixed capital formation, at constant 1990 prices							
Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006	1999	2000	2001	2002	2003	2004	2005	2006
Algeria	Mrd USD	313.3	316.4	319.8	324.3	329.5	336.0	343.7	352.7	15.3	15.7	16.1	17.3	18.2	19.6	21.2	22.7
Argentina	Mrd USD	622.6	636.1	643.1	638.0	640.9	653.6	674.4	702.9	41.2	38.4	32.4	20.6	28.5	38.3	46.9	55.5
Bangladesh	Mrd USD	97.8	106.3	115.3	124.9	135.3	146.7	159.5	173.2	11.6	12.5	13.2	14.3	15.4	16.8	18.6	20.1
Bolivia	Mrd USD	20.5	20.9	21.1	21.4	21.6	21.7	21.9	22.2	1.4	1.2	1.0	1.2	1.0	1.0	1.1	1.2
Brazil	Mrd USD	1,888.9	1,933.6	1,977.1	2,012.5	2,041.2	2,078.8	2,119.2	2,170.0	114.5	120.3	120.8	114.5	109.2	119.2	123.5	135.6
Cameroon	Mrd USD	35.0	35.9	37.4	38.9	40.2	41.8	43.3	44.7	2.2	2.3	2.9	3.0	2.8	3.2	3.2	3.2
Chile	Mrd USD	167.0	177.5	188.3	198.9	210.2	223.0	240.3	257.6	15.8	17.2	17.9	18.2	19.2	21.2	26.2	27.0
China	Mrd USD	2,558.0	2,835.5	3,136.2	3,479.1	3,886.3	4,344.4	4,853.0	5,419.6	343.6	379.9	414.1	468.4	546.3	613.6	682.4	760.7
Colombia	Mrd USD	199.2	201.4	204.6	208.4	213.8	220.8	230.8	243.7	10.4	10.2	11.2	12.0	13.7	15.6	18.9	22.1
CostaRica	Mrd USD	27.1	28.4	29.7	31.1	32.6	34.1	35.6	37.4	2.4	2.4	2.4	2.6	2.8	2.8	2.9	3.2
Coted'Ivoire	Mrd USD	33.5	33.2	33.5	33.9	34.1	34.4	34.7	34.8	2.0	1.0	1.7	1.7	1.6	1.7	1.6	1.5
Dom. Republic	Mrd USD	39.9	42.6	45.0	47.6	49.1	50.6	52.4	55.0	3.8	4.3	4.1	4.3	3.5	3.4	3.9	4.7
Ecuador	Mrd USD	43.1	43.4	44.2	45.4	46.6	47.9	49.5	51.2	1.8	2.1	2.5	3.0	3.0	3.2	3.5	3.6
Egypt	Mrd USD	160.2	171.1	182.5	194.6	207.5	222.0	239.1	261.7	17.7	17.3	18.2	19.4	20.7	22.8	26.0	32.2
El Salvador	Mrd USD	16.7	17.5	18.2	19.0	19.8	20.5	21.2	22.0	1.4	1.5	1.5	1.5	1.6	1.5	1.5	1.6
Ghana	Mrd USD	30.0	32.5	35.7	37.9	40.9	43.8	48.6	54.1	4.6	3.7	4.5	3.6	4.5	4.5	6.6	7.4
Guatemala	Mrd USD	23.6	24.9	26.1	27.5	28.7	29.9	31.1	32.6	2.4	2.2	2.2	2.4	2.3	2.3	2.4	2.8
Honduras	Mrd USD	14.7	15.6	16.3	17.0	17.7	18.6	19.6	20.7	1.5	1.4	1.4	1.3	1.4	1.7	1.7	1.9
India	Mrd USD	1,388.0	1,480.8	1,580.3	1,686.2	1,812.9	1,974.0	2,167.6	2,393.1	148.8	148.4	158.7	169.0	194.2	233.5	272.6	312.2
Indonesia	Mrd USD	562.8	582.0	603.1	625.5	647.3	675.0	707.5	740.1	36.5	41.7	44.4	46.5	46.8	53.6	59.5	60.9
Iran	Mrd USD	519.1	540.1	562.9	586.8	610.1	639.4	673.3	707.3	36.5	41.7	44.4	46.5	46.8	53.6	59.5	60.9
Israel	Mrd USD	258.7	270.5	281.0	289.7	297.0	304.3	311.8	321.0	21.5	22.2	21.3	19.9	19.0	19.1	19.7	21.6
Jamaica	Mrd USD	26.8	27.0	27.4	27.8	28.2	28.7	29.1	29.7	1.2	1.3	1.5	1.5	1.5	1.6	1.6	1.7

Source: Nehru et al (1993), United Nations Statistics Division and own calculations.

Appendix 4.G. Stock of capital series of the developing countries, at constant 1990 prices (K) (*continued*)

		Stock of capital, at constant 1990 prices								Fixed capital formation, at constant 1990 prices							
Country	**Unit**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Jordan	Mrd USD	17.6	18.2	18.6	19.1	19.7	20.6	21.5	22.7	1.4	1.2	1.2	1.2	1.3	1.7	1.8	2.0
Kenya	Mrd USD	40.5	41.5	42.8	43.9	44.7	45.7	47.4	49.7	2.5	2.7	3.0	2.8	2.6	2.8	3.5	4.2
Madagascar	Mrd USD	6.8	7.1	7.4	7.5	7.8	8.2	8.6	9.2	0.4	0.5	0.6	0.4	0.6	0.7	0.7	0.9
Malaysia	Mrd USD	298.8	313.8	327.7	341.2	354.9	369.1	384.1	400.8	21.5	27.0	26.4	26.6	27.4	28.3	29.7	32.1
Mexico	Mrd USD	1,081.6	1,126.9	1,165.4	1,201.8	1,237.1	1,277.7	1,322.4	1,374.5	79.5	88.6	83.6	83.0	83.3	90.0	95.8	105.1
Morocco	Mrd USD	116.1	121.9	127.6	133.9	140.7	148.3	156.6		10.2	10.5	10.6	11.3	12.2	13.2	14.2	15.6
Nicaragua	Mrd USD	11.7	12.4	12.9	13.4	13.9	14.5	15.2	15.8	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1.3
Pakistan	Mrd USD	170.7	177.1	183.3	189.8	195.2	202.1	211.6	223.7	12.7	13.3	13.3	13.8	13.0	14.7	17.6	20.5
Panama	Mrd USD	25.3	26.5	27.1	27.6	28.4	29.3	30.4		2.4	2.2	1.6	1.5	1.9	2.1	2.2	2.6
Paraguay	Mrd USD	17.7	17.8	18.0	18.0	18.1	18.3	18.5	18.8	0.9	0.9	0.8	0.8	0.8	0.9	1.0	1.0
Peru	Mrd USD	150.4	154.2	157.0	159.7	162.8	166.5	171.4	178.1	10.3	9.8	9.0	9.0	9.5	10.2	11.5	13.6
Philippines	Mrd USD	175.6	183.4	189.0	194.7	200.6	206.4	211.1	216.2	12.4	14.9	12.9	13.2	13.7	13.9	13.0	13.5
Singapore	Mrd USD	252.7	270.0	285.5	297.4	307.8	319.9	331.5	345.9	25.0	27.4	26.3	23.2	22.3	24.4	24.4	27.6
South Africa	Mrd USD	455.6	463.5	471.9	481.1	492.4	506.0	522.4	543.0	25.0	26.1	27.0	28.0	30.6	33.3	36.7	41.5
Tunisia	Mrd USD	57.1	59.7	62.4	64.9	67.1	69.4	71.6	74.3	4.5	4.8	5.1	5.0	4.9	4.9	5.0	5.5
Turkey	Mrd USD	811.7	845.3	857.8	876.5	902.0	943.7	997.2	1,060.7	56.2	66.1	46.3	53.1	60.6	77.7	91.3	103.4

Source: Nehru et al (1993), United Nations Statistics Division and own calculations.

Appendix 4.H. Public expenditures series of the developed countries, at constant 2000 prices (G)

Country	Unit	1996	1998	2000	2002	2003	2004	2005	2006	Unit	1996	1998	2000	2002	2003	2004	2005	2006
Austria	% of GDP	0.52	0.50	0.49	0.48	0.48	0.51	0.47	0.47	Mrd EURO-ATS	95.1	97.3	100.7	100.9	103.5	111.9	105.8	108.7
Belgium	% of GDP	0.44	0.43	0.43	0.44	0.46	0.45	0.48	0.45	Mrd EURO-BEF	97.8	101.2	107.2	113.6	118.9	119.7	130.6	124.9
Canada	% of GDP	0.37	0.37	0.34	0.35	0.36	0.35	0.35	0.35	Mrd CAD	334.8	354.3	366.1	399.4	411.2	413.8	423.1	439.7
Denmark	% of GDP	0.53	0.52	0.50	0.51	0.52	0.52	0.51	0.50	Mrd DKK	614.3	630.1	645.9	673.4	686.4	699.6	699.1	710.2
Finland	% of GDP	0.56	0.49	0.46	0.47	0.48	0.48	0.49	0.47	Mrd EURO-FIM	60.4	59.4	60.2	64.5	67.6	70.4	72.7	74.0
France	% of GDP	0.51	0.49	0.49	0.50	0.50	0.50	0.51	0.50	Mrd EURO-FRF	645.6	662.6	702.2	736.9	756.3	774.6	793.9	802.1
Germany	% of GDP	0.46	0.45	0.42	0.45	0.46	0.44	0.44	0.43	Mrd EURO-DEM	864.2	875.2	865.4	943.3	948.4	933.6	935.8	932.3
Greece	% of GDP	0.34	0.36	0.39	0.40	0.40	0.41	0.39	0.38	Mrd EURO-GRD	39.5	45.6	53.6	58.0	61.9	66.0	65.3	66.9
Ireland	% of GDP	0.35	0.31	0.29	0.32	0.32	0.32	0.33	0.33	Mrd EURO-IEP	24.8	26.9	30.7	37.9	39.4	41.7	44.7	48.0
Italy	% of GDP	0.41	0.41	0.40	0.42	0.43	0.43	0.43	0.44	Mrd EURO-ITL	448.6	464.8	474.1	508.2	525.6	531.1	541.0	559.8
Japan	% of GDP	0.33	0.39	0.36	0.36	0.36	0.35	0.36	0.34	100 Mrd JPY	1,636.4	1,907.8	1,795.9	1,809.2	1,828.0	1,816.3	1,933.1	1,847.8
Luxembourg	% of GDP	0.41	0.41	0.37	0.41	0.42	0.42	0.41	0.38	Mrd EURO-LUF	6.8	7.6	8.2	9.7	9.9	10.6	10.9	10.6
Netherlands	% of GDP	0.44	0.42	0.41	0.43	0.44	0.44	0.42	0.43	Mrd EURO-NLG	156.4	161.3	169.3	185.0	190.4	190.7	189.4	200.0
Norway	% of GDP	0.46	0.47	0.41	0.45	0.46	0.44	0.41	0.39	Mrd NOK	598.3	661.4	604.1	693.8	718.2	708.3	676.2	658.2
Portugal	% of GDP	0.39	0.40	0.40	0.41	0.43	0.44	0.45	0.44	Mrd EURO-PTE	40.6	44.8	49.0	52.0	53.3	55.5	57.5	56.3
Spain	% of GDP	0.38	0.37	0.36	0.36	0.36	0.37	0.37	0.37	Mrd EURO-ESP	200.5	211.1	226.1	242.7	249.2	263.1	271.3	282.9
Sweden	% of GDP	0.58	0.54	0.52	0.54	0.55	0.54	0.53	0.52	Mrd SEK	1,116.8	1,118.0	1,172.6	1,249.6	1,298.0	1,327.8	1,361.5	1,393.2
Switzerland	% of GDP	0.33	0.34	0.33	0.34	0.35	0.34	0.34	0.32	Mrd CHF	127.8	135.8	140.4	147.8	148.9	151.1	152.3	150.0
United Kingdom	% of GDP	0.39	0.36	0.34	0.39	0.40	0.41	0.42	0.42	Mrd GBP	328.4	327.0	332.4	398.6	420.8	442.4	463.4	477.0
United States	% of GDP	0.32	0.30	0.30	0.33	0.34	0.34	0.34	0.33	Mrd USD	2,661.7	2,763.0	3,002.8	3,368.0	3,518.6	3,625.7	3,750.7	3,807.2

Source: Schneider and Buehn (2009) and own calculations.

Appendix 4.I. Public expenditures series of the developing countries, at constant 1990 prices (G)

Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006	Unit	1999	2000	2001	2002	2003	2004	2005	2006
Algeria	% of GDP	13.6	14.7	15.4	14.8	13.8	11.4	11.2	13.6	Mrd USD	12.0	9.9	11.0	12.1	12.4	12.2	10.6	10.6
Argentina	% of GDP	13.8	14.2	12.2	11.4	11.1	11.9	12.4	13.8	Mrd USD	29.6	29.5	28.9	22.3	22.7	24.0	28.1	31.8
Bangladesh	% of GDP	4.6	4.5	5.0	5.3	5.5	5.5	5.5	4.6	Mrd USD	1.9	2.0	2.1	2.5	2.8	3.0	3.2	3.4
Bolivia	% of GDP	14.5	15.7	16.0	16.5	16.3	16.0	14.4	14.5	Mrd USD	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.2
Brazil	% of GDP	19.2	19.8	20.6	19.4	19.2	19.9	20.0	19.2	Mrd USD	119.1	117.3	122.9	130.9	124.8	130.8	139.8	146.2
Cameroon	% of GDP	9.5	10.2	10.2	10.0	10.2	10.0	9.6	9.5	Mrd USD	1.3	1.3	1.5	1.6	1.6	1.7	1.7	1.7
Chile	% of GDP	12.5	12.6	12.8	12.0	11.4	11.1	10.5	12.5	Mrd USD	7.4	7.8	8.1	8.4	8.2	8.3	8.5	8.3
China	% of GDP	12.5	12.6	12.8	12.0	11.4	11.1	10.5	12.5	Mrd USD	124.7	135.8	148.7	165.3	170.3	178.2	190.5	201.0
Colombia	% of GDP	18.9	19.1	18.7	18.3	17.6	17.5	16.9	18.9	Mrd USD	13.4	13.1	13.6	13.6	14.0	14.1	14.7	15.3
CostaRica	% of GDP	13.3	14.3	14.8	14.5	14.1	13.8	13.5	13.3	Mrd USD	1.5	1.6	1.7	1.9	1.9	2.0	2.0	2.2
Coted'Ivoire	% of GDP	15.5	14.0	16.1	13.7	12.2	12.6	14.1	15.5	Mrd USD	2.3	2.3	2.1	2.4	2.0	1.8	1.9	2.2
Dom. Republic	% of GDP	7.8	8.5	8.7	7.1	6.2	6.7	7.2	7.8	Mrd USD	1.1	1.3	1.5	1.6	1.3	1.1	1.3	1.6
Ecuador	% of GDP	9.8	10.3	10.8	11.6	11.4	11.1	11.0	9.8	Mrd USD	1.7	1.4	1.5	1.7	1.8	1.9	2.0	2.1
Egypt	% of GDP	11.1	11.8	12.2	11.6	11.1	11.1	10.7	11.1	Mrd USD	6.4	6.9	7.6	8.2	8.1	8.2	8.7	9.0
El Salvador	% of GDP	10.2	10.5	10.3	9.9	9.6	9.6	9.6	10.2	Mrd USD	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Ghana	% of GDP	16.9	17.8	17.6	17.7	16.5	15.3	13.4	16.9	Mrd USD	1.3	1.6	1.8	1.8	1.9	1.9	1.9	1.7
Guatemala	% of GDP	9.3	10.1	9.7	9.6	8.8	8.5	8.4	9.3	Mrd USD	0.8	1.0	1.1	1.0	1.1	1.0	1.0	1.0
Honduras	% of GDP	13.4	14.7	15.0	14.9	15.0	15.5	15.0	13.4	Mrd USD	0.6	0.7	0.8	0.8	0.8	0.9	1.0	1.0
India	% of GDP	12.6	12.4	11.9	11.3	10.7	10.5	10.2	12.6	Mrd USD	69.3	70.2	72.4	72.1	74.2	76.6	81.7	87.3
Indonesia	% of GDP	6.5	6.9	7.3	8.1	8.3	8.1	8.6	6.5	Mrd USD	10.9	12.4	13.6	14.9	17.5	18.9	19.4	21.8
Iran	% of GDP	6.5	6.9	7.3	8.1	8.3	8.1	8.6	6.5	Mrd USD	7.8	8.7	9.5	10.7	12.8	13.7	14.0	15.8
Israel	% of GDP	26.1	27.3	28.8	27.8	26.5	25.7	25.5	26.1	Mrd USD	25.4	26.5	27.7	29.0	28.5	28.5	29.0	30.3
Jamaica	% of GDP	14.3	13.9	14.3	13.8	12.4	13.8	13.9	14.3	Mrd USD	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.9
Jordan	% of GDP	23.7	22.9	22.7	23.2	21.3	19.5	22.3	23.7	Mrd USD	1.5	1.5	1.5	1.6	1.7	1.7	1.7	2.1

Source: United Nations Statistics Division and own calculations.

Appendix 4.I. Public expenditures series of the developing countries, at constant 1990 prices (G) *(continued)*

Country	Unit	1999	2000	2001	2002	2003	2004	2005	2006	Unit	1999	2000	2001	2002	2003	2004	2005	2006
Kenya	% of GDP	15.3	16.0	17.1	18.1	17.9	17.4	16.6	15.3	Mrd USD	2.1	2.0	2.2	2.4	2.6	2.7	2.8	2.8
Madagascar	% of GDP	7.9	8.8	8.4	10.5	9.1	9.0	8.7	7.9	Mrd USD	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Malaysia	% of GDP	10.2	12.0	13.0	13.0	12.6	12.3	11.9	10.2	Mrd USD	9.0	9.2	11.0	12.5	13.2	13.7	14.1	14.5
Mexico	% of GDP	10.6	11.2	11.6	11.8	10.8	10.8	10.5	10.6	Mrd USD	39.9	43.1	45.4	47.2	49.0	46.3	48.1	48.9
Morocco	% of GDP	18.4	18.6	18.3	18.1	18.7	19.4	18.5	18.4	Mrd USD	6.5	6.7	7.3	7.4	7.8	8.4	9.0	9.3
Nicaragua	% of GDP	17.5	17.7	18.0	18.2	18.5	19.3	19.6	17.5	Mrd USD	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0
Pakistan	% of GDP	7.8	8.7	8.8	8.2	7.8	10.8	9.1	7.8	Mrd USD	6.9	6.3	7.3	7.7	7.8	8.0	11.7	10.5
Panama	% of GDP	13.2	13.9	14.8	14.0	13.6	13.2	12.3	13.2	Mrd USD	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.6
Paraguay	% of GDP	12.7	12.1	11.3	10.5	9.9	10.9	11.2	12.7	Mrd USD	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
Peru	% of GDP	10.6	10.7	10.1	10.3	10.0	10.1	9.5	10.6	Mrd USD	4.6	4.6	4.7	4.6	4.9	5.0	5.4	5.5
Philippines	% of GDP	13.1	12.2	11.5	11.1	10.1	9.7	9.8	13.1	Mrd USD	7.4	7.8	7.5	7.3	7.4	7.2	7.2	7.7
Singapore	% of GDP	10.8	12.0	12.3	12.0	10.8	10.6	10.6	10.8	Mrd USD	7.0	8.4	9.1	9.7	9.8	9.6	10.2	11.0
South Africa	% of GDP	18.1	18.3	18.4	19.3	19.4	19.6	19.8	18.1	Mrd USD	23.7	24.3	25.2	26.3	28.4	29.9	31.7	33.7
Tunisia	% of GDP	15.6	15.6	15.9	15.5	15.3	15.3	15.0	15.6	Mrd USD	2.9	3.0	3.2	3.3	3.4	3.6	3.7	3.8
Turkey	% of GDP	11.7	12.4	12.7	12.2	11.9	11.8	12.3	11.7	Mrd USD	33.3	34.0	33.9	37.0	37.3	40.0	42.8	47.8

Source: United Nations Statistics Division and own calculations.

Appendix 4.J. Tax-to-output ratio of the developed countries (τ)

		Total tax burden, including imputed social security contributions								GDP at current prices							
Country	Unit	1996	1998	2000	2002	2003	2004	2005	2006	1996	1998	2000	2002	2003	2004	2005	2006
Austria	Mrd EURO-ATS	81.4	85.5	88.9	91.5	94.1	100.2	100.1	101.8	180.1	183.5	190.9	198.0	207.5	212.5	218.8	223.3
Belgium	Mrd EURO-BEF	98.1	103.8	109.2	113.3	118.9	122.4	126.9	129.1	211.4	221.2	229.7	238.6	252.2	259.4	268.3	275.7
Canada	Mrd CAD	538.6	564.0	586.9	620.1	651.6	660.8	671.0	687.4	1,069.5	1,125.6	1,163.6	1,213.5	1,294.0	1,335.6	1,372.7	1,400.7
Denmark	Mrd DKK	47.2	50.3	54.4	56.6	62.7	62.6	64.4	64.4	99.3	107.6	117.1	122.7	132.2	139.8	143.8	145.8
Finland	Mrd EURO-FIM	564.9	585.9	610.4	642.5	666.0	687.5	698.8	715.5	1,227.3	1,267.4	1,323.7	1,368.0	1,441.4	1,497.2	1,548.6	1,594.8
France	Mrd EURO-FRF	792.8	808.6	833.4	868.9	893.1	875.1	879.2	889.3	1,876.2	1,915.6	1,965.4	2,012.0	2,062.5	2,113.2	2,143.2	2,163.8
Germany	Mrd EURO-DEM	30.8	35.4	40.7	44.7	49.9	51.6	55.9	58.8	98.4	108.9	118.4	126.2	136.3	146.4	156.6	172.4
Greece	Mrd EURO-GRD	20.4	23.1	26.0	30.0	34.4	36.3	38.8	42.4	58.7	67.9	78.6	90.4	104.8	116.9	130.3	139.8
Ireland	Mrd EURO-IEP	424.3	463.2	467.9	483.1	501.8	522.4	533.7	556.3	1,003.8	1,048.8	1,091.4	1,127.1	1,191.1	1,248.6	1,295.2	1,335.4
Italy	Mrd EURO-ITL	1,400.4	1,436.9	1,386.5	1,359.2	1,394.0	1,426.6	1,342.1	1,335.5	5,050.1	5,156.4	5,049.1	4,976.3	5,029.9	4,977.2	4,913.1	4,902.9
Japan	100 Mrd JPY	6.1	6.6	7.0	7.8	8.8	9.2	9.6	10.1	15.8	16.4	17.4	19.9	22.0	22.6	24.0	25.8
Luxembourg	Mrd EURO-LUF	132.5	139.7	147.0	160.1	171.1	176.4	180.2	183.1	319.8	342.2	362.5	386.2	418.0	447.7	465.2	476.9
Netherlands	Mrd EURO-NLG	431.2	465.0	472.2	518.2	625.0	652.1	654.1	666.7	1,033.0	1,119.2	1,140.4	1,240.4	1,481.2	1,536.9	1,532.3	1,593.8
Norway	Mrd NOK	30.4	33.0	36.3	39.7	43.0	45.0	48.2	49.9	90.5	97.9	106.5	114.2	122.3	129.3	135.4	138.6
Portugal	Mrd EURO-PTE	161.2	173.6	186.7	203.7	222.8	237.4	257.9	276.6	473.9	503.9	539.5	579.9	630.3	680.7	729.2	782.9
Spain	Mrd EURO-ESP	943.4	990.7	1,047.4	1,112.1	1,179.5	1,174.7	1,175.7	1,233.7	1,852.1	1,927.0	2,012.1	2,124.0	2,250.0	2,326.2	2,420.8	2,515.2
Sweden	Mrd SEK	106.0	106.3	113.3	115.3	126.3	126.6	129.4	128.0	376.7	384.0	395.3	402.9	422.1	430.3	434.3	437.7
Switzerland	Mrd CHF	279.6	300.8	327.7	348.9	372.1	387.8	392.0	412.6	781.7	830.1	879.1	928.7	976.5	1,021.8	1,075.6	1,139.7
United Kingdom	Mrd GBP	2,222.6	2,397.3	2,571.0	2,737.1	2,947.9	2,938.0	2,789.9	2,858.7	7,783.9	8,278.9	8,741.0	9,301.0	9,898.8	10,233.9	10,590.2	11,089.2
United States	Mrd USD	81.4	85.5	88.9	91.5	94.1	100.2	100.1	101.8	180.1	183.5	190.9	198.0	207.5	212.5	218.8	223.3

Source: Schneider and Buehn (2009) and own calculations.

Appendix 4.J. Tax-to-output ratio of the developed countries (τ) (*continued*)

		Tax-to-outpt ratio								
Country	Unit	1996	1998	2000	2002	2003	2004	2005	2006	Time average
Austria	% of GDP	0.452	0.466	0.453	0.458	0.456	0.450	0.440	0.436	0.451
Belgium	% of GDP	0.464	0.475	0.471	0.473	0.468	0.469	0.469	0.465	0.469
Canada	% of GDP	0.504	0.504	0.504	0.489	0.491	0.501	0.519	0.507	0.349
Denmark	% of GDP	0.476	0.465	0.474	0.448	0.442	0.437	0.442	0.436	0.502
Finland	% of GDP	0.460	0.461	0.462	0.451	0.449	0.452	0.455	0.459	0.452
France	% of GDP	0.423	0.424	0.433	0.410	0.411	0.402	0.402	0.405	0.456
Germany	% of GDP	0.313	0.343	0.366	0.357	0.341	0.333	0.340	0.339	0.414
Greece	% of GDP	0.348	0.331	0.328	0.298	0.303	0.316	0.321	0.336	0.342
Ireland	% of GDP	0.423	0.429	0.421	0.412	0.417	0.409	0.407	0.423	0.323
Italy	% of GDP	0.277	0.275	0.277	0.273	0.272	0.266	0.276	0.289	0.417
Japan	% of GDP	0.386	0.404	0.400	0.401	0.390	0.382	0.385	0.364	0.276
Luxembourg	% of GDP	0.414	0.406	0.409	0.387	0.384	0.385	0.386	0.398	0.389
Netherlands	% of GDP	0.417	0.414	0.422	0.427	0.418	0.429	0.431	0.436	0.396
Norway	% of GDP	0.336	0.341	0.352	0.356	0.360	0.352	0.363	0.370	0.424
Portugal	% of GDP	0.340	0.346	0.354	0.354	0.353	0.357	0.369	0.377	0.354
Spain	% of GDP	0.509	0.521	0.524	0.486	0.490	0.494	0.502	0.497	0.356
Sweden	% of GDP	0.281	0.287	0.299	0.298	0.292	0.289	0.292	0.291	0.503
Switzerland	% of GDP	0.358	0.373	0.381	0.364	0.362	0.367	0.377	0.384	0.291
United Kingdom	% of GDP	0.286	0.294	0.298	0.263	0.258	0.260	0.275	0.282	0.371
United States	% of GDP	0.452	0.466	0.453	0.458	0.456	0.450	0.440	0.436	0.277

Source: Schneider and Buehn (2009) and own calculations.

Appendix 4.K. Tax-to-output ratio of the developing countries (τ)

Country	Current tax burden: total economy (% GDP)
Algeria	0.077
Argentina	0.229
Bangladesh	0.085
Bolivia	0.270
Brazil	0.388
Cameroon	0.182
Chile	0.171
China	0.170
Colombia	0.230
Costa Rica	0.140
Côte d'Ivoire	0.153
Dominican Republic	0.150
Ecuador	0.132
Egypt	0.158
El Salvador	0.133
Ghana	0.208
Guatemala	0.119
Honduras	0.156
India	0.177
Indonesia	0.110
Iran	0.073
Israel	0.368
Jamaica	0.272
Jordan	0.211
Kenya	0.184
Madagascar	0.107
Malaysia	0.155
Mexico	0.097
Morocco	0.223
Nicaragua	0.178
Pakistan	0.102
Panama	0.106
Paraguay	0.120
Peru	0.151
Philippines	0.144
Singapore	0.130
South Africa	0.269
Tunisia	0.149
Turkey	0.325

Source: Heritage Foundation.

Appendix 4.L. Logaritmization

The logarithmization of the equations describing the official economy yields the following result:

$$\ln Y^{o}(t) = \ln\left(A\left(\frac{G(t)}{\overline{K}}\right)^{\alpha}\left(K^{o}(t)\right)^{1-\alpha}\right)$$

$$\Leftrightarrow \ln Y^{o}(t) = \ln A + \alpha\left[\ln G(t) - \ln\overline{K}\right] + (1-\alpha)\ln K^{o}(t)$$

$$\Leftrightarrow \ln Y^{o}(t) = \ln A + \alpha \ln G(t) - \alpha \ln\overline{K} + (1-\alpha)\ln\psi\overline{K}(t), \text{ where } \psi = \frac{K^{o}(t)}{\overline{K}(t)}$$

$$\Leftrightarrow \ln Y^{o}(t) = \ln A + \alpha \ln G(t) - \alpha \ln\overline{K}(t) + (1-\alpha)\left[\ln\psi + \ln\overline{K}(t)\right]$$

$$\Leftrightarrow \ln Y^{o}(t) = \ln A + \alpha \ln G(t) + (1-2\alpha)\ln\overline{K}(t) + (1-\alpha)\ln\psi_{o}, \ \psi_{o} = \frac{K^{o}(t)}{\overline{K}(t)}$$

$$\Leftrightarrow \ln Y^{o}(t) = \left[\ln A + (1-\alpha)\ln\psi_{o}\right] + \alpha \ln G(t) + (1-2\alpha)\ln\overline{K}(t)$$

$$\Leftrightarrow \ln Y^{o}(t) = \mu_{1} + \mu_{2}\ln G(t) + \mu_{3}\ln\overline{K}(t)$$

where $\mu_{1} = \ln A + (1-\alpha)\ln\psi_{o}$, $\psi_{o} = \frac{K^{o}(t)}{\overline{K}(t)}$

$\mu_{2} = \alpha$

$\mu_{3} = (1-2\alpha)$

The logarithmization of the equations describing the underground economy yields the following result:

$$\ln Y^{u}(t) = \ln\left(B\left(\frac{\gamma G(t)}{\overline{K}}\right)^{\beta}\left(K^{u}(t)\right)^{1-\beta}\right)$$

$$\Leftrightarrow \ln Y^{u}(t) = \ln B + \beta\left[\ln\gamma n\gamma G(- \ln\overline{K}\right] + (1-\beta)\ln K^{u}(t)$$

$$\Leftrightarrow \ln Y^{u}(t) = \ln B + \beta\left[\ln\gamma + \ln G(t)\right] - \beta\ln\overline{K}(t) + (1-\beta)\ln\psi_{u}\overline{K}(t), \text{ where }, \ \psi_{u} = \frac{K^{u}(t)}{\overline{K}(t)}$$

$$\Leftrightarrow \ln Y^{u}(t) = \ln B + \beta\left[\ln\gamma + \ln G(t)\right] - \beta\ln\overline{K}(t) + (1-\beta)\left[\ln\psi_{u} + \ln\overline{K}(t)\right]$$

$$\Leftrightarrow \ln Y^{u}(t) = \ln B + \beta\ln\gamma + \beta\ln G(t) - \beta\ln\overline{K}(t) + (1-\beta)\ln\psi_{u} + (1-\beta)\ln\overline{K}(t)$$

$$\Leftrightarrow \ln Y^{u}(t) = \left[\ln B + \beta\ln\gamma + (1-\beta)\ln\psi_{u}\right] + \beta\ln G(t) + (1-2\beta)\ln\overline{K}(t)$$

$$\Leftrightarrow \ln Y^{u}(t) = \upsilon_{1} + \upsilon_{2}\ln G(t) + \upsilon_{3}\ln\overline{K}(t)$$

where $\upsilon_{1} = \ln B + \beta\ln\gamma + (1-\beta)\ln\psi_{u}$, $\psi_{u} = \frac{K^{u}(t)}{\overline{K}(t)}$

$\upsilon_{2} = \beta$

$\upsilon_{3} = (1-2\beta)$

Appendix 4.M. Estimation results

Developed world – official economy

Dependent Variable: LOG(YO)
Method: Least Squares
Date: 04/02/10 Time: 18:15
Sample: 1 160
Included observations: 160
LOG(YO)=C(1)+C(2)* LOG(G)+(1-2*C(2))* LOG(K)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.661665	0.070117	-9.436624	0.0000
C(2)	0.038584	0.007417	5.201897	0.0000

R-squared	0.990011	Mean dependent var	6.397922
Adjusted R-squared	0.989948	S.D. dependent var	1.452478
S.E. of regression	0.145624	Akaike info criterion	-1.003163
Sum squared resid	3.350581	Schwarz criterion	-0.964723
Log likelihood	82.25305	Durbin-Watson stat	1.975250

Developed world – underground economy

Dependent Variable: LOG(YU)
Method: Least Squares
Date: 04/02/10 Time: 18:14
Sample: 1 160
Included observations: 160
LOG(YU)=C(1)+C(2)* LOG(G)+(1-2*C(2))* LOG(K)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-2.779856	0.174592	-15.92205	0.0000
C(2)	0.047605	0.018469	2.577557	0.0109

R-squared	0.940125	Mean dependent var	4.195609
Adjusted R-squared	0.939746	S.D. dependent var	1.477201
S.E. of regression	0.362605	Akaike info criterion	0.821413
Sum squared resid	20.77417	Schwarz criterion	0.859853
Log likelihood	-63.71308	Durbin-Watson stat	1.848341

Developing world – official economy

Dependent Variable: LOG(YO)
Method: Least Squares
Date: 04/03/10 Time: 21:40
Sample: 1 295
Included observations: 295
LOG(YO) = C(1)+.03125*LOG(G)+C(3)*LOG(K)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.876027	0.031950	-27.41829	0.0000
C(3)	0.946438	0.006327	149.5913	0.0000

R-squared	0.987858	Mean dependent var	3.719577
Adjusted R-squared	0.987817	S.D. dependent var	1.540323
S.E. of regression	0.170017	Akaike info criterion	-0.699081
Sum squared resid	8.469383	Schwarz criterion	-0.674085
Log likelihood	105.1145	Durbin-Watson stat	2.187033

Developing world – underground economy

Dependent Variable: LOG(YU)
Method: Least Squares
Date: 04/03/10 Time: 21:48
Sample: 1 295
Included observations: 295
LOG(YU) = C(1)+C(2)*LOG(G)+.75*LOG(K)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-1.169552	0.031069	-37.64361	0.0000
C(2)	0.116620	0.013767	8.471024	0.0000

R-squared	0.930854	Mean dependent var	2.622895
Adjusted R-squared	0.930618	S.D. dependent var	1.391287
S.E. of regression	0.366471	Akaike info criterion	0.836960
Sum squared resid	39.35012	Schwarz criterion	0.861956
Log likelihood	-121.4516	Durbin-Watson stat	1.891466

Appendix 4.N. Probability that the developed economies are operating above their natural levels of the underground economy

In this appendix, the probability is determined that the economy is operating above its natural level of underground economic activity. The access to public goods and services when producing underground (γ) and the loss of income when operating underground (λ), are both contained in the interval [0,1]. Therefore, a random series with 10,000 observations is generated assuming a uniform distribution U(0,1). Based on the distributional sample obtained, the probability that the underground economy as measured by Schneider and Buehn (2009) equals or exceeds its natural level is estimated. This is done by using the observations generated for in the place of γ and λ, respectively, to estimate the size of the underground economy and comparing these estimates with the respective natural level. The number of times this occurs is subsequently expressed as a percentage of the total. This represents the probability that the economy is operating above its natural level of underground economic activity. The same exercise was performed for the truncated distribution sample obtained from generating 10,000 observations with a normal distribution N(0,1) for the domain [0,1].

The results, for each country in the sample, are reported in Figures 4.N.1. and 4.N.2. for partial simulations performed with the access to public goods and services when producing underground (γ) and the loss of income when operating underground (λ), respectively.

Figure 4.N.1. Probability that the economy is operating above its natural level of the underground economy for different values of γ

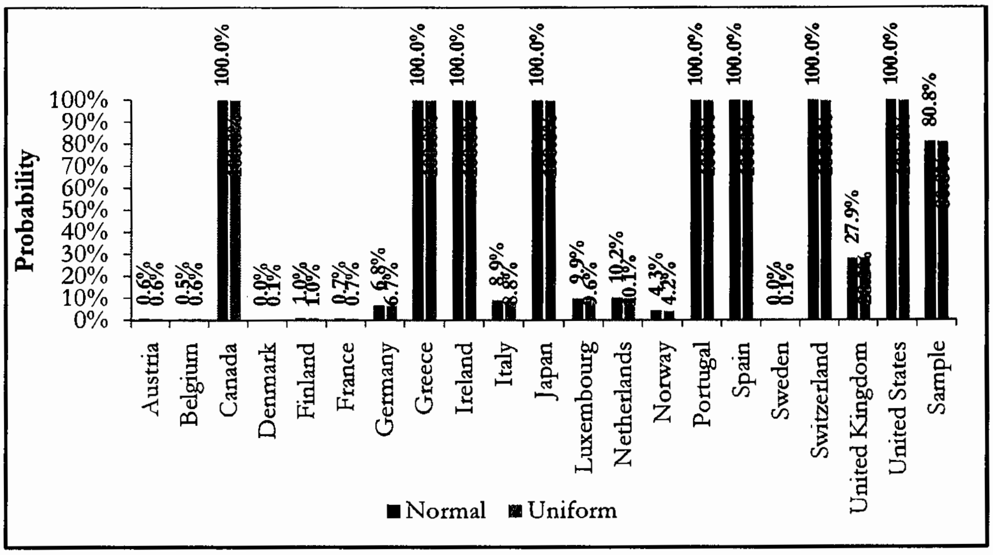
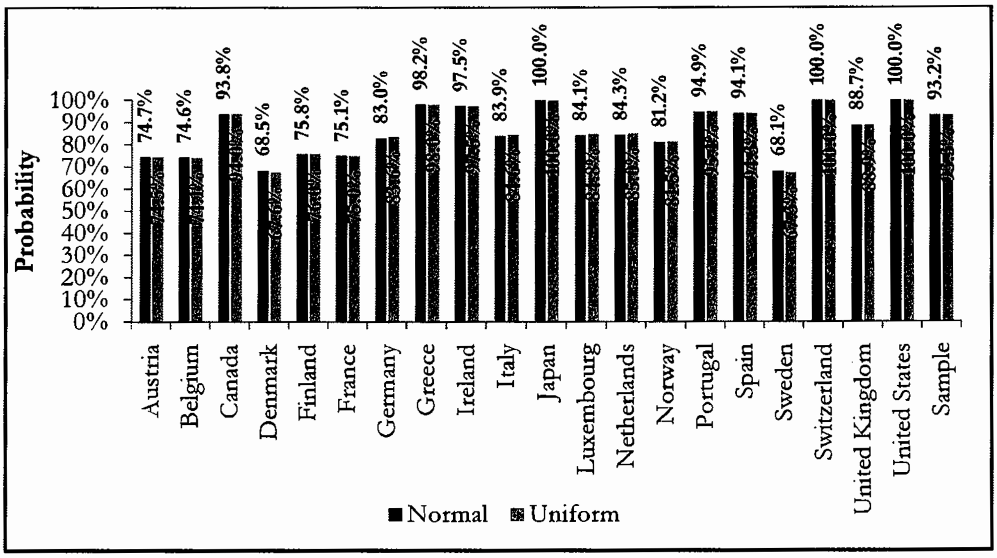


Figure 4.N.2. Probability that the economy is operating above its natural level of the underground economy for different values of λ



The results reported in Figures 4.N.1. and 4.N.2. suggest that some developed economies are most likely operating with an underground sector that is larger than it should be based on structural features.

Appendix 4.O. Probability that the developing economies are operating above their natural levels of the underground economy for different values of γ

Using the random series previously generated in Appendix 4.N. and following the same procedure as well, the probability that the underground economy as measured by Schneider and Buehn (2009) matches or exceeds its natural level is estimated. This represents the probability that the economy is operating above its natural level of the underground economy. The results are reported for each country in the sample in the figures 4.O.1 and 4.O.2 for partial simulations performed with the access to public goods and services when producing underground (γ) and the loss of income when operating underground (λ), respectively.

Figure 4.O.1. Probability that the economy is operating above its natural level of the underground economy for different values of γ

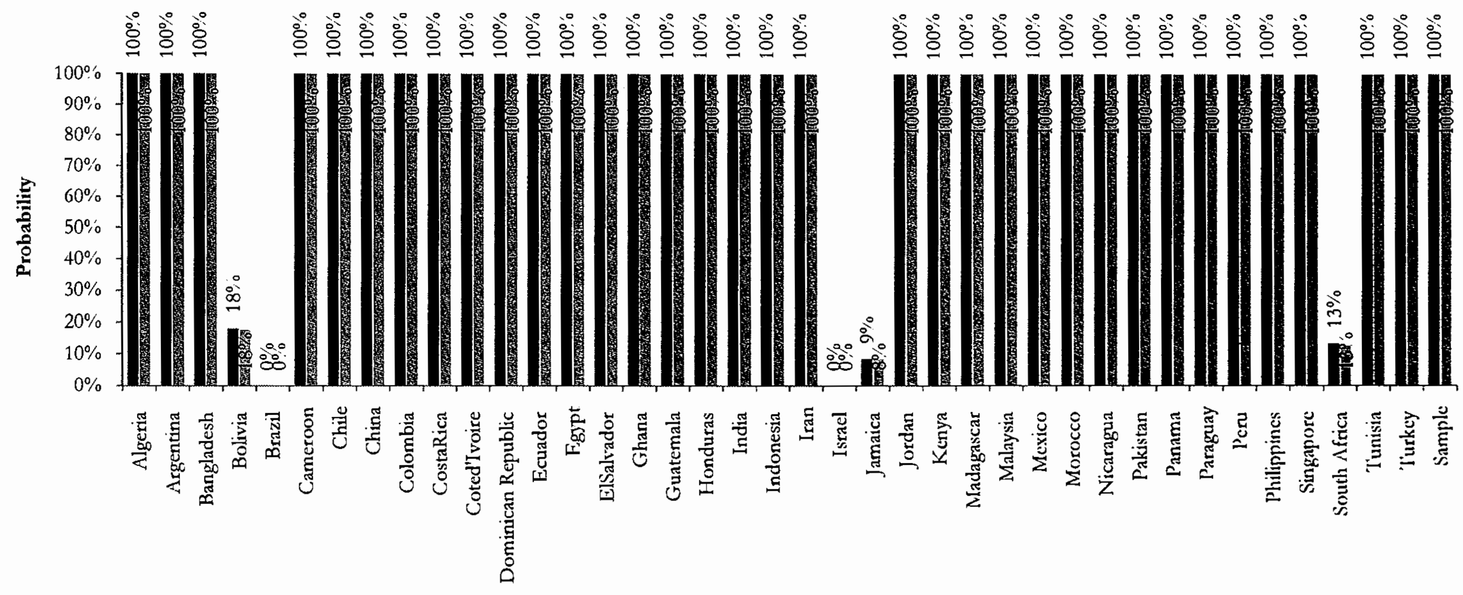
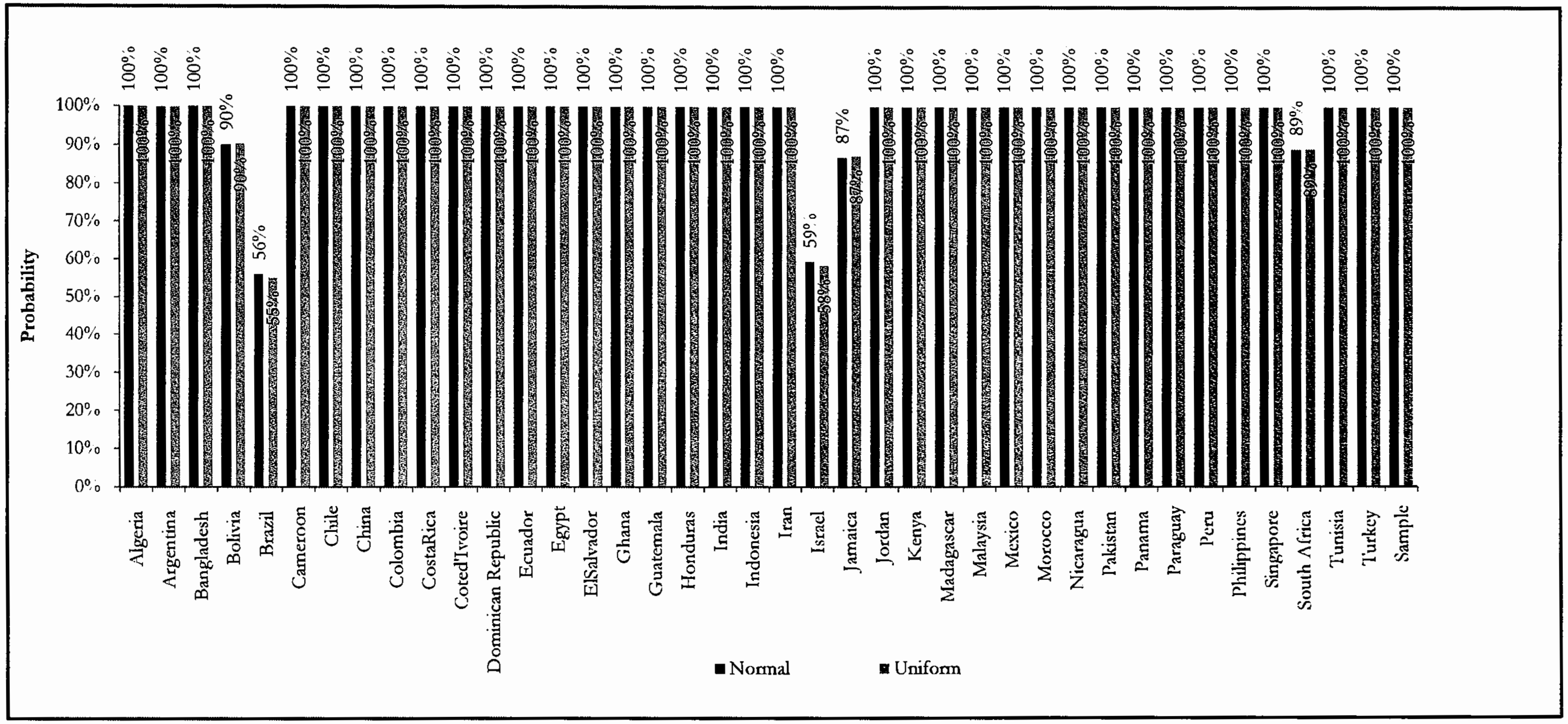


Figure 4.O.2. Probability that the economy is operating above its natural level of the underground economy for different values of λ



APPENDICES CHAPTER 5

Appendix 5.A. Data

The data used in this chapter and its sources are described in this Appendix. The data refer to a set of developed and developing countries. Different data sources are used for the developed world and the developing world, respectively. This is mentioned explicitly, where applicable.

<u>Cyclically adjusted primary public expenditures</u>

The primary public expenditures series refers to total public expenditure excluding interest of the general government. The AMECO database reports this series adjusted for the cyclical component using the potential Gross Domestic Product (GDP) as a percentage of GDP at market prices for Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. This series is reported in the table in Appendix 5.B.

The data for the other countries refers to the cyclically adjusted public expenditures. Due to the lack of data on interest expenses of the general government, it could not be subtracted from the total public expenditures to obtain the primary public expenditures. This series is constructed following Fedelino et al (2009): a constant zero elasticity of the public expenditures with respect to the output gap is assumed to construct the cyclically adjusted public expenditures series. The elasticity of the public expenditures is close to zero, as most public spending is not correlated to the output gap, except for items like unemployment benefits. These, however, typically represent a small share of total public spending. This implies that the cyclically adjusted public expenditures may be proxied by the unadjusted public expenditures. The unadjusted public expenditures data is obtained from the World Economic Outlook database of the International Monetary Fund. This series is reported in the table in Appendix 5.C.

Cyclically adjusted public revenues

The public revenues series refers to total public revenues, including tax revenue and non-tax revenue. The AMECO database reports this series adjusted for the cyclical component using the potential GDP as a percentage of GDP at market prices for Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. This series is reported in the table in Appendix 5.D.

The data for the other countries is constructed following once again Fedelino et al (2009). This means that a constant unitary elasticity of the public revenue with respect to the output gap is assumed. So, the cyclically adjusted public revenues are constructed as follows:

$$T(t)_{\text{Cyclically adjusted}}=T(t)*\frac{Y^{p}}{Y}$$

where Y^p refers to the potential output. The potential output, i.e. the output if the economy operates at its potential, is determined by applying the Hodrick-Prescott filter to the GDP data. The public expenditures and GDP data are obtained from the World Economic Outlook database of the International Monetary Fund. This series is reported in the table in Appendix 5.E.

Cyclically-adjusted primary budget balance as a percentage of GDP (CAPB)

The CAPB is calculated by subtracting the cyclically adjusted primary public expenditures from the cyclically adjusted public revenues. This series is reported for the developed world in the table in Appendix 5.F.

The fiscal change is measured as the yearly change of the CAPB, i.e. the first difference of the CAPB [d(CAPB$_t$)]. This series is reported in the table in Appendix 5.G. Fiscal changes that meet the requirements established in Chapter 5 are referred to as fiscal consolidation episodes.

Cyclically-adjusted budget balance as a percentage of GDP (CAB)

The CAB is calculated by subtracting the cyclically adjusted public expenditures from the cyclically adjusted public revenues. This series is reported for the developing world in the table in Appendix 5.H.

The fiscal change is measured as the yearly change of the CAB, i.e. the first difference of the CAB [d(CAB$_t$)]. This series is reported in the table in Appendix 5.I. Fiscal changes that meet the requirements established in Chapter 5 are referred to as fiscal consolidation episodes.

Numerical fiscal rules

Numerical fiscal rules establish permanent constraints on the discretionary use of fiscal policy. This occurs through numerical limits on budgetary aggregates, like the public deficit, the public debt or a major component thereof. This definition follows Kopits and Symansky (1998), as adopted in the European Commission, Public Finances in EMU (2010), p. 98 – 115, and the Fiscal Affairs Department of the International Monetary Fund (2009).

The fiscal rules applicable to the members of the European Union are measured here by the index produced by the European Commission in Public Finances in EMU (2010). It covers the years 1990 through 2008. For the years 1981 through 1989 its value is set equal to the average value for 1990 – 1991 for each country This series is reported in the table in Appendix 5.J.

For the developing world no consistent data is available.

Expenditure Composition

This variable measures the extent to which the fiscal adjustment occurs by cutting expenditures or by raising more revenues. This is calculated by expressing yearly changes of the (primary) public expenditures as discussed above as a percentage of the yearly changes of the cyclically-adjusted (primary) budget balance as a percentage of GDP. If the (primary) public expenditures increase relative to the year before, expenditure cuts are not contributing to the fiscal consolidation effort. Then this variable is normalized to zero (0). If the reduction of the (primary) public expenditures exceeds the improvement of the yearly change of the cyclically-adjusted (primary) budget balance as a percentage of GDP, this variable is normalized to one (1). This series is reported in the tables in Appendices 5.K and 5.L for the developed world and for the developing world, respectively.

Economic situation prior to the initiation of the fiscal consolidation episode(Output-gap$_{t-1}$)

The economic situation prior to the initiation of the fiscal consolidation episode, i.e. in the year before the start of the fiscal consolidation, is measured by the output gap in (t-1). It refers to the gap between actual and potential GDP at 2000 market prices and is expressed as a percentage of potential GDP at market prices. This series is provided by the AMECO database for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom.

The data for the other countries is calculated by applying the Hodrick-Prescott filter to the GDP data to obtain a proxy for the potential output. The output gap is expressed as a fraction of potential output, as follows:

$$\text{Output gap}_t = \frac{Y - Y^p}{Y}$$

This series is reported in the tables in Appendices 5.M and 5.N for the developed world and for the developing world, respectively.

Fiscal situation prior to the initiation of a fiscal consolidation episode (b_{t-1})

The fiscal situation prior to the initiation of the fiscal consolidation episode is measured by the debt ratio in the year before the start of the fiscal consolidation (b_{t-1}), as provided by the AMECO database for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. It refers to the general government consolidated gross debt as a percentage of GDP at market prices.

The debt ratio data for the other countries is obtained from the World Economic Outlook database of the International Monetary Fund.

This series is reported in the tables in Appendices 5.O and 5.P for the developed world and for the developing world, respectively.

Fiscal threshold

The fiscal threshold corresponds with the tax burden up to where tax increases yield higher tax revenues and from where further tax increases induce a sufficiently large erosion of the tax base, due to an expansion of the (natural level of the) underground economy, such that the tax revenues decline. The tax revenues are maximized at the fiscal threshold. The fiscal threshold was estimated in Chapter 4 at 34.3% for the developed world and 23.1% for the developing world.

Tax burden (τ)

The tax burden is calculated for the developed world by dividing the current tax revenues for the total economy by the GDP at current market prices. The tax burden for the developing world is obtained from the Heritage Foundation. This series is reported in the tables in Appendices 5.Q and 5.R for the developed world and for the developing world, respectively.

Relative position to the fiscal threshold (τ-relative)

This variable measures the position of the economy relative to the fiscal threshold. It equals the difference between the tax burden during the consolidation episode and the fiscal threshold. This series is reported in the tables in Appendices 5.S and 5.T for the developed world and for the developing world, respectively.

Role of the Underground Economy (RUE)

The role of the underground economy is a binary variable and is given by:

$$\text{RUE} = \begin{cases} 1 & \text{if fiscal consolidation is pursued by increasing revenues, while the tax burden exceeds the fiscal threshold} \\ 0 & \text{else} \end{cases}$$

It is constructed by multiplying two binary variables. The first one refers to the position of the economy relative to the fiscal threshold. This variable equals one (1) if the tax burden exceeds the fiscal threshold and zero (0) if the tax burden is lower than the fiscal threshold. The second one refers to the consolidation strategy, i.e. the extent to which the consolidation efforts is undertaken by cutting expenditures or raising more revenues. If increasing revenues represents more than half the consolidation effort, i.e. if the Expenditure Composition variable is less than 0.5, then the binary variable equals one (1) and zero (0) if not, i.e. if cutting expenditures is the main component of the consolidation strategy.

This series is reported in the tables in Appendices 5.U and 5.V for the developed world and for the developing world, respectively.

Successfulness of the fiscal episode

As defined earlier, a fiscal consolidation episode is successful if three years after its conclusion the public-debt-ratio (b_{t+3}) is relatively at least five percentage points lower than its value immediately before its start (b_{t-1}). This is a binary variable and equals one (1) whenever the fiscal consolidation episode is successful and zero (0) whenever the fiscal consolidation episode is unsuccessful. This series is reported in the tables in Appendices 5.U and 5.V for the developed world and for the developing world, respectively.

Appendix 5.B. Cyclically adjusted primary public expenditures (e) – developed world

Cyclically adjusted total expenditure excluding interest of general government										
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	47.7	48.6	48.9	39.3	44.4	46.0	n.a.	n.a.	36.4
1981	% GDP	48.8	53.5	50.8	40.1	46.6	46.1	n.a.	n.a.	39.5
1982	% GDP	49.0	50.4	51.7	41.6	47.9	45.7	n.a.	n.a.	40.1
1983	% GDP	49.6	52.5	49.9	43.0	48.0	44.5	n.a.	n.a.	41.1
1984	% GDP	49.3	49.3	47.4	42.8	48.8	43.8	n.a.	n.a.	40.7
1985	% GDP	50.1	47.9	46.2	44.6	49.1	43.2	n.a.	43.3	41.4
1986	% GDP	50.7	46.9	44.2	45.4	48.4	42.7	n.a.	43.4	41.7
1987	% GDP	50.7	45.7	46.2	46.3	47.8	43.3	n.a.	42.0	41.9
1988	% GDP	49.8	44.1	48.5	45.2	47.5	42.9	32.7	39.6	42.1
1989	% GDP	48.3	41.3	48.8	43.7	46.4	41.4	33.9	34.8	42.5
1990	% GDP	48.1	40.8	48.5	47.2	46.9	42.0	35.9	35.2	42.8
1991	% GDP	49.0	42.5	49.0	55.0	47.9	44.0	33.1	36.9	42.7
1992	% GDP	49.7	43.0	50.7	59.2	48.9	44.4	33.9	37.8	43.1
1993	% GDP	52.5	44.1	52.8	59.6	51.5	45.0	35.1	37.9	43.6
1994	% GDP	52.4	43.4	53.8	58.9	50.7	44.7	32.1	37.8	42.1
1995	% GDP	52.2	43.3	53.3	57.2	50.9	44.8	34.5	35.8	40.9
1996	% GDP	51.9	44.0	53.2	55.7	50.8	45.8	33.6	34.6	40.9
1997	% GDP	49.9	43.6	51.8	52.5	50.5	44.9	35.6	33.0	41.0
1998	% GDP	50.3	43.1	51.9	49.6	49.3	44.7	36.2	31.2	41.0
1999	% GDP	50.2	43.4	51.5	48.9	49.6	44.9	37.0	31.8	41.5
2000	% GDP	48.6	42.7	50.3	45.8	48.9	42.1	39.3	29.5	39.8
2001	% GDP	48.1	42.7	50.9	45.4	48.7	44.7	38.8	31.7	41.7
2002	% GDP	47.6	44.1	51.4	46.8	49.8	45.2	39.5	32.1	41.7
2003	% GDP	48.3	45.7	52.1	48.3	50.5	45.3	39.8	31.9	43.1
2004	% GDP	51.0	44.7	52.0	48.4	50.5	44.1	40.7	32.4	43.0
2005	% GDP	47.1	48.0	50.9	48.6	50.8	43.8	39.3	32.9	43.5
2006	% GDP	46.5	44.7	50.2	47.7	50.2	42.5	40.6	33.5	44.1
2007	% GDP	45.7	44.7	49.6	46.3	49.7	41.0	41.8	35.9	42.9
2008	% GDP	46.3	46.5	50.5	48.2	49.9	41.2	44.2	41.3	43.7
2009	% GDP	49.5	50.3	55.7	54.0	53.4	44.4	47.9	46.5	47.2
2010	% GDP	49.9	49.5	55.5	54.1	53.8	44.1	43.8	64.2	46.3

Source: AMECO database. n.a. stands for 'not avaialable'.

Appendix 5.B. Cyclically adjusted primary public expenditures (e) – developed world

(continued)

	Cyclically adjusted total expenditure excluding interest of general government							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	n.a.	52.0	n.a.	30.0	n.a.	n.a.	n.a.
1981	% GDP	n.a.	52.5	n.a.	31.4	n.a.	n.a.	n.a.
1982	% GDP	n.a.	53.6	n.a.	31.4	n.a.	n.a.	n.a.
1983	% GDP	n.a.	53.1	n.a.	29.8	n.a.	n.a.	n.a.
1984	% GDP	n.a.	52.1	n.a.	29.0	n.a.	n.a.	n.a.
1985	% GDP	n.a.	51.0	n.a.	31.1	n.a.	n.a.	n.a.
1986	% GDP	n.a.	50.9	n.a.	31.0	n.a.	n.a.	39.9
1987	% GDP	n.a.	52.3	n.a.	30.5	n.a.	n.a.	38.2
1988	% GDP	n.a.	50.4	n.a.	29.9	n.a.	n.a.	36.2
1989	% GDP	n.a.	49.0	n.a.	30.5	n.a.	n.a.	35.7
1990	% GDP	37.3	49.6	0.5	30.7	n.a.	n.a.	37.5
1991	% GDP	38.0	49.3	0.5	33.4	n.a.	n.a.	39.6
1992	% GDP	39.6	49.5	0.5	34.7	n.a.	n.a.	41.9
1993	% GDP	39.3	49.4	0.5	36.9	n.a.	65.3	41.9
1994	% GDP	38.5	47.8	0.5	36.3	n.a.	62.9	41.1
1995	% GDP	39.2	45.8	0.5	35.9	39.2	59.3	40.3
1996	% GDP	40.7	44.0	0.5	37.2	37.8	57.2	38.7
1997	% GDP	40.2	42.7	0.4	37.4	36.9	55.2	37.0
1998	% GDP	40.6	42.1	0.5	37.8	36.9	54.1	36.0
1999	% GDP	38.9	42.0	0.5	38.2	36.4	54.1	36.1
2000	% GDP	37.3	40.9	0.4	38.3	36.0	51.8	34.1
2001	% GDP	37.9	42.4	0.4	39.7	35.7	51.8	37.9
2002	% GDP	41.3	43.3	0.5	39.6	36.2	52.6	39.1
2003	% GDP	41.6	44.1	0.5	41.1	36.0	53.4	40.2
2004	% GDP	42.4	43.3	0.4	42.1	36.8	52.5	41.0
2005	% GDP	41.4	42.2	0.4	43.3	36.7	52.2	42.0
2006	% GDP	38.4	43.3	0.4	41.8	36.8	51.3	42.2
2007	% GDP	36.0	43.4	0.4	41.0	37.6	49.6	41.8
2008	% GDP	36.6	44.1	0.4	40.7	39.7	50.0	45.2
2009	% GDP	41.7	48.6	0.4	45.3	43.8	53.2	49.6
2010	% GDP	42.5	49.1	0.4	46.3	43.5	51.8	48.3

Source: AMECO database. n.a. stands for 'not avaialable'.

Appendix 5.C. Cyclically adjusted public expenditures (e) – developing world

	Cyclically adjusted total expenditure of general government										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1980	% GDP	n.a.	n.a.	15.030	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	14.078	46.703	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	14.472	24.987	n.a.	n.a.	n.a.	27.858	15.017	n.a.
1983	% GDP	n.a.	n.a.	14.505	32.072	n.a.	n.a.	n.a.	28.343	15.029	n.a.
1984	% GDP	n.a.	n.a.	12.918	29.028	n.a.	n.a.	n.a.	26.900	15.273	n.a.
1985	% GDP	n.a.	n.a.	12.756	21.782	n.a.	n.a.	n.a.	25.776	14.659	n.a.
1986	% GDP	n.a.	n.a.	13.472	22.231	n.a.	n.a.	n.a.	25.625	14.136	n.a.
1987	% GDP	n.a.	n.a.	12.979	24.419	n.a.	n.a.	n.a.	23.444	14.683	n.a.
1988	% GDP	n.a.	n.a.	12.745	23.975	n.a.	n.a.	n.a.	20.854	14.515	n.a.
1989	% GDP	n.a.	n.a.	13.134	24.409	n.a.	n.a.	n.a.	21.410	17.667	n.a.
1990	% GDP	25.637	n.a.	12.653	22.776	n.a.	n.a.	n.a.	20.983	17.404	n.a.
1991	% GDP	28.392	n.a.	12.656	24.181	n.a.	n.a.	n.a.	19.062	17.647	n.a.
1992	% GDP	28.727	n.a.	12.748	25.253	n.a.	n.a.	n.a.	16.863	18.362	n.a.
1993	% GDP	32.821	n.a.	13.494	27.181	n.a.	n.a.	n.a.	15.450	19.952	n.a.
1994	% GDP	31.054	n.a.	13.790	26.767	n.a.	n.a.	n.a.	14.204	20.520	n.a.
1995	% GDP	29.381	25.548	14.531	25.781	n.a.	n.a.	n.a.	12.730	22.140	n.a.
1996	% GDP	28.195	25.408	13.320	26.048	38.980	n.a.	n.a.	12.306	24.857	n.a.
1997	% GDP	30.401	25.265	13.137	28.280	39.463	n.a.	n.a.	13.162	26.186	n.a.
1998	% GDP	30.939	25.925	12.812	29.973	42.311	n.a.	n.a.	14.912	25.777	n.a.
1999	% GDP	31.843	28.493	12.206	29.728	40.707	n.a.	n.a.	16.785	27.783	n.a.
2000	% GDP	28.742	28.229	13.439	29.800	35.287	16.543	n.a.	17.050	26.288	21.817
2001	% GDP	31.251	29.750	13.972	32.595	37.165	16.836	n.a.	17.908	27.558	23.169
2002	% GDP	34.293	38.483	14.709	33.749	39.529	15.702	n.a.	18.878	27.690	24.688
2003	% GDP	32.232	30.340	13.688	32.546	39.160	15.399	n.a.	18.602	27.180	23.929
2004	% GDP	30.831	31.98	13.264	33.537	37.569	15.973	n.a.	18.136	26.155	23.174
2005	% GDP	27.201	31.206	13.845	33.775	39.150	14.610	21.051	18.608	25.850	22.604
2006	% GDP	28.805	30.934	13.906	31.854	39.447	14.548	19.724	18.909	28.070	21.632
2007	% GDP	33.464	33.60	13.419	31.866	38.282	15.745	20.409	18.896	28.219	21.384
2008	% GDP	38.124	33.613	15.922	34.769	37.956	18.497	22.813	20.043	26.529	22.658
2009	% GDP	41.573	37.597	14.129	35.148	39.331	18.443	26.003	23.002	29.250	25.446
2010	% GDP	48.163	38.125	13.515	33.607	38.018	19.508	25.620	22.304	28.221	27.557

Source: WEO database. n.a. stands for 'not avaialable'.

Appendix 5.C. Cyclically adjusted public expenditures (e) – developing world (*continued*)

	Cyclically adjusted total expenditure of general government									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	20.535	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	19.192	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	20.531	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	11.445	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	14.380	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	18.198	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	18.252	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	19.533	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	19.046	n.a.	n.a.	19.527
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	16.730	n.a.	n.a.	25.923
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	16.035	n.a.	n.a.	26.062
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	18.400	n.a.	n.a.	25.402
1992	% GDP	n.a.	n.a.	n.a.	n.a.	18.143	24.399	n.a.	n.a.	24.588
1993	% GDP	n.a.	n.a.	n.a.	n.a.	16.359	29.454	n.a.	n.a.	24.107
1994	% GDP	n.a.	n.a.	n.a.	n.a.	15.919	31.332	n.a.	n.a.	24.014
1995	% GDP	n.a.	n.a.	n.a.	n.a.	15.776	31.483	n.a.	n.a.	23.239
1996	% GDP	n.a.	n.a.	n.a.	n.a.	17.580	29.826	n.a.	n.a.	22.607
1997	% GDP	22.127	n.a.	n.a.	n.a.	14.138	29.563	n.a.	n.a.	23.385
1998	% GDP	21.214	n.a.	n.a.	n.a.	15.148	29.187	n.a.	n.a.	23.925
1999	% GDP	19.790	n.a.	n.a.	n.a.	15.487	27.576	n.a.	n.a.	25.154
2000	% GDP	18.434	11.917	n.a.	n.a.	17.999	29.697	14.322	23.549	25.974
2001	% GDP	16.907	13.445	24.821	n.a.	20.790	32.281	14.510	26.710	26.058
2002	% GDP	19.621	17.057	24.567	34.577	18.005	26.313	13.871	26.191	26.416
2003	% GDP	19.635	17.436	22.720	35.189	19.110	29.846	15.130	28.176	26.144
2004	% GDP	20.096	17.105	22.883	33.853	18.301	33.670	13.412	26.556	25.401
2005	% GDP	19.858	16.409	23.679	33.245	18.515	31.675	13.720	25.614	24.809
2006	% GDP	20.810	17.435	23.595	37.766	19.141	34.890	14.672	25.994	24.663
2007	% GDP	20.500	16.955	26.822	35.266	18.337	38.055	14.281	25.987	25.003
2008	% GDP	21.146	19.339	34.476	35.568	18.649	42.386	13.638	27.965	27.158
2009	% GDP	21.065	17.117	32.298	34.753	20.956	37.608	14.220	29.439	28.534
2010	% GDP	22.166	16.311	32.636	33.248	21.435	40.797	14.681	28.275	27.884

Source: WEO database. n.a. stands for 'not avaialable'.

Appendix 5.C. Cyclically adjusted public expenditures (e) – developing world (*continued*)

	Cyclically adjusted total expenditure of general government										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	29.892	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	24.535	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	21.547	19.790	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	19.477	18.300	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	19.805	18.921	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	20.757	16.099	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	20.368	15.076	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	20.608	13.291	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	21.219	15.239	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	21.722	20.081	n.a.	n.a.	n.a.
1990	% GDP	n.a.	18.264	n.a.	n.a.	44.243	22.881	17.384	36.210	25.946	28.572
1991	% GDP	n.a.	17.223	n.a.	17.716	45.179	21.888	16.735	32.496	22.299	26.106
1992	% GDP	n.a.	17.741	n.a.	17.267	35.689	23.439	20.456	33.649	20.958	28.572
1993	% GDP	n.a.	33.953	n.a.	18.688	36.972	25.197	21.016	29.094	20.793	29.54
1994	% GDP	n.a.	28.644	n.a.	19.229	34.972	25.030	20.165	27.725	21.179	27.598
1995	% GDP	n.a.	25.777	n.a.	21.161	36.119	23.075	17.975	26.595	24.691	27.238
1996	% GDP	n.a.	24.612	n.a.	25.831	36.904	22.822	18.137	26.487	25.847	22.424
1997	% GDP	n.a.	24.069	n.a.	27.797	34.566	23.294	17.737	24.405	26.407	23.581
1998	% GDP	n.a.	23.145	n.a.	28.096	35.958	22.458	20.352	24.265	24.65	21.195
1999	% GDP	n.a.	21.695	n.a.	28.328	33.721	20.120	18.161	25.100	24.96	20.900
2000	% GDP	16.644	18.097	48.136	26.464	33.814	20.475	18.481	25.772	22.558	25.847
2001	% GDP	21.996	19.013	50.715	27.655	33.259	22.269	18.7620	30.516	22.803	26.830
2002	% GDP	18.738	22.323	51.897	29.629	33.634	23.364	16.703	29.705	23.377	26.016
2003	% GDP	19.716	22.767	51.289	30.619	36.764	23.22	20.619	30.714	22.807	24.083
2004	% GDP	19.931	22.780	48.341	30.854	37.719	22.642	26.490	28.272	20.632	24.185
2005	% GDP	18.753	28.591	46.248	29.195	38.846	24.177	21.427	26.641	22.193	28.378
2006	% GDP	20.120	29.830	45.601	29.659	34.993	24.648	21.507	27.109	22.436	26.552
2007	% GDP	19.725	28.261	44.579	30.292	35.608	25.992	18.673	27.886	22.72	26.293
2008	% GDP	20.393	27.169	43.804	32.685	33.254	27.117	18.624	28.840	24.25	29.912
2009	% GDP	17.204	27.365	42.353	36.358	33.177	28.986	15.281	32.520	27.112	28.965
2010	% GDP	17.300	26.161	41.999	32.735	29.329	30.519	11.985	30.470	25.646	27.971

Source: WEO database. n.a. stands for 'not avaialable'.

Appendix 5.C. Cyclically adjusted public expenditures (e) – developing world (*continued*)

	Cyclically adjusted total expenditure of general government										
	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	12.679	n.a.	18.227	0	n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	31.545	11.293	n.a.	19.947	17.874	n.a.	n.a.	n.a.
1991	% GDP	n.a.	n.a.	14.530	14.459	n.a.	19.379	18.231	n.a.	31.096	n.a.
1992	% GDP	n.a.	n.a.	19.291	17.119	n.a.	19.693	17.930	n.a.	29.564	n.a.
1993	% GDP	n.a.	22.845	23.515	16.796	n.a.	18.950	15.525	n.a.	30.513	n.a.
1994	% GDP	n.a.	19.508	5.635	17.050	n.a.	20.304	14.913	n.a.	29.930	n.a.
1995	% GDP	n.a.	19.241	11.013	19.734	n.a.	19.659	16.029	n.a.	30.655	n.a.
1996	% GDP	n.a.	20.394	16.461	19.803	n.a.	19.939	20.569	n.a.	31.890	n.a.
1997	% GDP	n.a.	18.596	23.64	22.789	n.a.	20.664	16.941	n.a.	28.697	n.a.
1998	% GDP	n.a.	19.039	25.489	22.548	n.a.	20.378	20.191	n.a.	28.656	n.a.
1999	% GDP	n.a.	17.565	25.667	24.899	n.a.	20.637	18.138	n.a.	28.902	n.a.
2000	% GDP	n.a.	18.337	25.415	25.814	20.910	19.925	18.690	25.051	29.036	n.a.
2001	% GDP	30.242	17.044	26.131	22.862	19.968	20.145	22.672	25.126	29.074	n.a.
2002	% GDP	25.590	19.716	26.175	23.837	19.427	19.933	18.802	25.113	29.805	42.614
2003	% GDP	26.921	17.084	27.008	20.267	19.273	19.679	17.845	25.866	29.293	40.952
2004	% GDP	27.091	16.936	26.009	19.572	18.718	18.590	16.499	25.894	29.226	35.101
2005	% GDP	27.566	18.386	24.937	20.578	18.900	17.942	14.510	26.117	29.284	32.375
2006	% GDP	27.706	19.521	24.424	20.957	18.151	17.535	14.859	25.963	29.170	32.674
2007	% GDP	28.204	20.754	24.340	19.605	17.735	17.277	14.076	26.358	29.441	33.331
2008	% GDP	29.332	22.269	25.524	17.913	18.827	17.105	18.840	29.397	30.539	33.823
2009	% GDP	30.860	19.603	25.626	22.696	21.071	18.551	19.806	32.067	30.818	37.319
2010	% GDP	31.080	20.728	25.887	22.690	20.783	18.888	19.363	32.316	31.020	35.664

Source: WEO database. n.a. stands for 'not avaialable'.

Appendix 5.D. Cyclically adjusted public revenues (r) – developed world

	Cyclically adjusted total revenue of general government									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	47.9	45.3	50.5	43.7	45.9	43.5	n.a.	n.a.	33.1
1981	% GDP	50.1	46.3	52.0	46.7	46.9	43.9	n.a.	n.a.	33.4
1982	% GDP	49.0	47.7	50.6	46.4	47.5	45.3	n.a.	n.a.	36.9
1983	% GDP	48.0	48.6	52.8	46.7	48.5	45.1	n.a.	n.a.	39.5
1984	% GDP	50.4	48.9	53.6	48.5	49.3	44.9	n.a.	n.a.	38.1
1985	% GDP	51.1	49.1	54.1	50.6	49.5	45.0	n.a.	43.8	37.8
1986	% GDP	50.5	48.5	54.5	51.8	48.4	44.2	n.a.	44.7	38.8
1987	% GDP	50.6	48.7	56.3	49.9	48.7	44.4	n.a.	44.4	38.3
1988	% GDP	50.0	46.4	58.4	50.9	46.8	43.3	28.7	44.5	38.8
1989	% GDP	48.5	44.3	57.7	49.4	45.9	43.5	27.5	39.7	39.2
1990	% GDP	48.5	44.8	55.3	51.7	45.9	41.5	30.3	38.6	40.7
1991	% GDP	49.0	45.6	54.6	57.0	47.1	41.9	31.0	41.1	42.2
1992	% GDP	51.1	45.3	56.0	59.2	47.1	43.5	32.6	42.0	45.1
1993	% GDP	52.5	48.3	58.7	59.1	49.4	45.3	34.9	42.9	47.5
1994	% GDP	51.7	47.7	57.6	58.5	49.4	45.4	36.6	42.9	45.3
1995	% GDP	50.6	47.7	56.7	56.2	49.5	44.9	37.0	39.0	45.3
1996	% GDP	51.9	48.8	57.0	57.0	51.3	46.1	37.7	38.9	45.9
1997	% GDP	51.9	48.7	55.7	54.4	51.5	45.8	39.0	37.2	47.8
1998	% GDP	51.2	49.4	55.9	53.3	50.1	45.9	40.5	36.0	46.5
1999	% GDP	50.7	49.0	56.2	52.2	50.2	46.5	41.3	35.3	46.8
2000	% GDP	49.3	48.0	54.7	53.4	48.8	45.7	42.9	34.4	44.7
2001	% GDP	51.3	49.2	54.8	51.8	48.7	44.2	40.8	33.4	44.2
2002	% GDP	50.2	49.6	54.8	52.4	48.5	44.5	40.6	32.7	43.9
2003	% GDP	50.7	51.3	55.4	52.5	48.6	45.1	38.8	33.7	44.8
2004	% GDP	50.1	48.6	56.3	51.7	48.8	44.0	37.6	35.3	44.0
2005	% GDP	48.8	49.0	57.2	52.2	49.7	44.3	38.6	35.4	43.5
2006	% GDP	47.5	48.0	55.2	51.7	49.6	43.6	38.5	36.8	44.4
2007	% GDP	46.9	46.9	54.3	50.2	48.7	43.1	38.5	35.3	45.0
2008	% GDP	47.0	48.1	55.1	52.0	49.3	43.2	38.6	35.5	45.6
2009	% GDP	49.9	49.4	58.4	55.8	50.0	46.1	38.0	36.8	48.4
2010	% GDP	49.3	49.3	54.6	54.8	50.3	43.7	42.4	37.0	47.3

Source: AMECO database. n.a. stands for 'not avaialable'.

Appendix 5.D. Cyclically adjusted public revenues (r) – developed world *(continued)*

	Cyclically adjusted total revenue of general government							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	n.a.	50.2	n.a.	25.2	n.a.	n.a.	42.2
1981	% GDP	n.a.	51.8	n.a.	26.8	n.a.	n.a.	45.3
1982	% GDP	n.a.	53.9	n.a.	28.5	n.a.	n.a.	46.0
1983	% GDP	n.a.	54.6	n.a.	29.9	n.a.	n.a.	44.3
1984	% GDP	n.a.	53.1	n.a.	30.2	n.a.	n.a.	44.2
1985	% GDP	n.a.	53.8	n.a.	30.2	n.a.	n.a.	43.1
1986	% GDP	n.a.	52.2	n.a.	32.5	n.a.	n.a.	41.7
1987	% GDP	n.a.	53.3	n.a.	30.9	n.a.	n.a.	39.9
1988	% GDP	n.a.	52.1	n.a.	32.7	n.a.	n.a.	39.1
1989	% GDP	n.a.	48.9	n.a.	32.9	n.a.	n.a.	39.1
1990	% GDP	41.4	48.6	0.6	31.1	n.a.	n.a.	38.7
1991	% GDP	37.7	51.5	0.6	33.4	n.a.	n.a.	40.3
1992	% GDP	39.6	51.3	0.6	37.4	n.a.	n.a.	39.8
1993	% GDP	41.2	53.4	0.5	37.1	n.a.	63.5	38.1
1994	% GDP	41.3	50.4	0.5	36.1	n.a.	62.6	37.9
1995	% GDP	42.8	47.5	0.5	37.4	39.0	59.0	38.0
1996	% GDP	43.8	47.8	0.5	38.1	39.3	61.2	38.0
1997	% GDP	45.1	46.2	0.5	37.8	38.8	60.4	38.1
1998	% GDP	44.3	45.5	0.5	36.8	37.9	60.4	39.0
1999	% GDP	41.2	45.7	0.5	37.4	38.0	58.8	39.2
2000	% GDP	40.6	45.1	0.6	37.0	37.2	57.9	39.4
2001	% GDP	42.3	44.5	0.6	37.1	37.2	56.0	39.9
2002	% GDP	41.9	44.4	0.6	38.9	38.0	54.1	38.5
2003	% GDP	42.0	44.8	0.6	41.2	38.1	54.4	38.1
2004	% GDP	41.2	45.0	0.6	41.7	38.5	53.8	38.7
2005	% GDP	40.9	45.1	0.6	40.4	39.3	54.7	40.1
2006	% GDP	39.0	46.1	0.6	40.8	40.0	53.1	40.7
2007	% GDP	38.0	44.7	0.6	40.6	40.5	52.4	40.3
2008	% GDP	39.2	45.9	0.6	40.6	37.1	52.9	42.3
2009	% GDP	43.8	47.4	0.6	39.8	36.3	56.1	42.6
2010	% GDP	43.3	47.1	n.a.	42.6	38.1	53.0	42.6

Source: AMECO database. n.a. stands for 'not avaialable'.

Appendix 5.E. Cyclically adjusted public revenues (r) – developing world

	Cyclically adjusted total revenue of general government										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1980	% GDP	n.a.	n.a.	6.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	6.9	35.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	6.7	8.9	n.a.	n.a.	n.a.	26.5	10.7	n.a.
1983	% GDP	n.a.	n.a.	6.6	12.4	n.a.	n.a.	n.a.	27.2	11.5	n.a.
1984	% GDP	n.a.	n.a.	6.5	3.7	n.a.	n.a.	n.a.	25.1	11.7	n.a.
1985	% GDP	n.a.	n.a.	6.9	12.3	n.a.	n.a.	n.a.	24.4	12.6	n.a.
1986	% GDP	n.a.	n.a.	7.1	20.7	n.a.	n.a.	n.a.	23.2	12.4	n.a.
1987	% GDP	n.a.	n.a.	6.9	17.5	n.a.	n.a.	n.a.	20.6	14.1	n.a.
1988	% GDP	n.a.	n.a.	7.2	18.1	n.a.	n.a.	n.a.	17.7	13.6	n.a.
1989	% GDP	n.a.	n.a.	7.3	19.4	n.a.	n.a.	n.a.	19.2	16.3	n.a.
1990	% GDP	28.1	n.a.	6.9	18.5	n.a.	n.a.	n.a.	20.1	17.1	n.a.
1991	% GDP	32.2	n.a.	7.3	19.8	n.a.	n.a.	n.a.	18.0	18.3	n.a.
1992	% GDP	29.2	n.a.	8.3	21.0	n.a.	n.a.	n.a.	15.0	18.5	n.a.
1993	% GDP	27.5	n.a.	9.1	21.1	n.a.	n.a.	n.a.	13.5	19.5	n.a.
1994	% GDP	30.6	n.a.	9.3	23.7	n.a.	n.a.	n.a.	11.2	19.8	n.a.
1995	% GDP	30.8	n.a.	9.3	23.7	n.a.	n.a.	n.a.	10.3	20.1	n.a.
1996	% GDP	32.5	n.a.	9.1	23.7	32.9	n.a.	22.6	10.4	21.6	n.a.
1997	% GDP	34.2	21.2	9.2	24.3	32.8	n.a.	22.2	11.1	21.8	n.a.
1998	% GDP	27.5	21.4	9.3	23.8	34.7	n.a.	22.2	11.9	21.7	n.a.
1999	% GDP	30.1	23.1	8.4	25.2	36.0	n.a.	22.7	13.2	23.7	n.a.
2000	% GDP	39.2	24.0	8.4	25.0	31.9	17.1	23.9	14.1	24.1	19.1
2001	% GDP	36.0	24.6	9.1	24.8	34.3	16.4	24.2	15.8	25.5	21.3
2002	% GDP	36.2	27.5	10.3	24.6	35.7	16.2	24.1	16.8	25.5	22.0
2003	% GDP	36.8	29.5	10.5	24.3	35.2	16.2	23.6	17.1	26.2	21.8
2004	% GDP	35.4	31.3	10.3	26.4	35.2	15.0	24.2	17.6	25.8	21.8
2005	% GDP	39.6	30.3	10.6	31.6	36.2	17.6	25.7	18.0	26.1	21.9
2006	% GDP	42.1	29.7	10.7	34.8	36.2	47.4	27.3	18.5	26.8	21.8
2007	% GDP	39.2	30.1	10.1	32.8	35.0	20.2	28.2	19.2	26.2	22.2
2008	% GDP	47.2	31.3	10.7	32.0	35.4	20.8	26.5	18.9	25.8	22.7
2009	% GDP	36.5	33.0	10.2	30.6	36.0	18.5	22.2	19.0	26.7	22.7

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.E. Cyclically adjusted public revenues (r) – developing world *(continued)*

	Cyclically adjusted total revenue of general government									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	7.4	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	5.9	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	11.6	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	8.3	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	11.8	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	15.0	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	15.5	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	17.3	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	15.8	n.a.	n.a.	13.3
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	14.5	n.a.	n.a.	17.1
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	11.3	n.a.	n.a.	16.8
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	14.4	n.a.	n.a.	17.8
1992	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	12.4	n.a.	n.a.	18.0
1993	% GDP	n.a.	n.a.	n.a.	n.a.	12.6	16.2	n.a.	n.a.	17.2
1994	% GDP	n.a.	n.a.	n.a.	n.a.	13.4	19.0	n.a.	n.a.	17.4
1995	% GDP	n.a.	n.a.	n.a.	n.a.	14.1	20.5	n.a.	n.a.	17.0
1996	% GDP	n.a.	n.a.	n.a.	n.a.	15.5	16.3	n.a.	n.a.	16.0
1997	% GDP	18.8	n.a.	n.a.	n.a.	12.8	14.4	n.a.	n.a.	15.9
1998	% GDP	17.5	n.a.	n.a.	n.a.	13.3	16.1	n.a.	n.a.	15.5
1999	% GDP	15.6	n.a.	n.a.	n.a.	13.1	13.6	n.a.	n.a.	16.0
2000	% GDP	16.8	12.8	n.a.	n.a.	14.8	20.0	12.3	24.3	16.8
2001	% GDP	17.7	14.4	25.2	n.a.	14.5	25.5	12.5	22.9	17.1
2002	% GDP	18.8	14.3	26.5	25.4	14.4	20.0	12.8	22.0	18.1
2003	% GDP	18.3	13.7	25.4	26.7	15.2	25.5	12.7	22.3	18.4
2004	% GDP	19.0	15.2	25.0	26.3	15.8	29.2	12.5	24.5	19.0
2005	% GDP	18.5	16.3	24.0	25.7	15.7	27.4	12.2	24.2	18.8
2006	% GDP	19.4	16.2	26.6	29.1	16.5	27.4	12.8	23.6	19.4
2007	% GDP	20.0	16.8	28.9	27.6	16.1	28.7	12.5	23.5	20.3
2008	% GDP	20.6	15.3	32.7	27.0	15.6	27.0	11.8	25.3	19.1
2009	% GDP	19.0	13.4	28.1	27.0	15.9	27.2	11.1	25.4	18.4

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.E. Cyclically adjusted public revenues (r) – developing world (*continued*)

	Cyclically adjusted total revenue of general government										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	13.8	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	11.1	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	17.5	10.3	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	17.1	10.2	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	17.4	10.7	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	17.7	12.8	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	16.9	11.9	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	17.8	10.4	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	18.4	13.9	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	18.1	14.7	n.a.	n.a.	n.a.
1990	% GDP	n.a.	16.2	n.a.	n.a.	40.4	17.9	15.4	35.3	22.8	26.1
1991	% GDP	n.a.	13.0	n.a.	20.0	38.8	12.9	11.2	32.9	21.0	23.3
1992	% GDP	n.a.	13.7	n.a.	19.6	37.5	12.6	14.0	34.7	20.6	26.2
1993	% GDP	n.a.	26.4	n.a.	20.6	34.3	14.3	13.0	31.3	20.6	28.0
1994	% GDP	n.a.	24.5	n.a.	21.1	31.8	20.2	11.4	32.0	19.9	23.6
1995	% GDP	n.a.	22.8	n.a.	22.3	32.8	23.1	11.7	26.6	21.5	25.5
1996	% GDP	n.a.	22.8	n.a.	22.0	32.7	22.1	13.2	25.7	21.1	22.9
1997	% GDP	n.a.	21.6	n.a.	21.8	31.0	22.5	15.1	25.7	20.5	26.2
1998	% GDP	n.a.	16.6	n.a.	22.8	30.4	23.0	13.7	25.5	18.4	22.6
1999	% GDP	n.a.	21.8	n.a.	24.9	31.4	21.6	14.7	24.5	18.7	25.0
2000	% GDP	15.3	24.9	43.5	25.7	30.8	20.6	14.8	21.2	18.5	24.6
2001	% GDP	20.2	20.7	45.8	24.2	31.2	19.9	13.2	27.0	19.2	22.7
2002	% GDP	18.6	23.2	48.8	23.9	30.5	21.5	11.2	26.1	20.0	22.8
2003	% GDP	18.9	24.0	46.5	24.9	36.5	21.7	16.0	26.2	21.0	21.9
2004	% GDP	19.8	24.4	45.5	25.9	37.7	23.4	20.7	24.7	19.4	22.6
2005	% GDP	19.6	30.2	44.9	25.5	33.7	22.7	16.9	23.7	20.8	24.6
2006	% GDP	20.4	29.5	44.4	24.7	31.0	21.9	59.2	24.8	20.9	25.2
2007	% GDP	18.3	29.6	43.6	25.7	30.3	22.2	15.6	24.6	20.7	27.8
2008	% GDP	19.8	26.8	40.9	26.1	27.9	22.9	15.8	24.8	22.2	30.7
2009	% GDP	15.2	26.1	37.0	27.3	24.8	23.5	12.4	27.6	23.6	25.8

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.E. Cyclically adjusted public revenues (r) – developing world (*continued*)

Cyclically adjusted total revenue of general government	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	14.6	n.a.	15.5	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	17.5	32.4	15.3	n.a.	15.7	29.7	n.a.	n.a.	n.a.
1991	% GDP	n.a.	17.3	15.0	14.8	n.a.	17.2	29.4	n.a.	26.9	n.a.
1992	% GDP	n.a.	15.6	17.9	15.9	n.a.	18.1	30.8	n.a.	26.1	n.a.
1993	% GDP	n.a.	15.6	17.2	17.4	n.a.	17.9	32.6	n.a.	27.8	n.a.
1994	% GDP	n.a.	14.1	16.5	19.4	n.a.	19.1	32.2	n.a.	29.0	n.a.
1995	% GDP	n.a.	13.3	18.0	19.5	n.a.	18.5	31.4	n.a.	28.3	n.a.
1996	% GDP	n.a.	14.0	18.4	19.1	n.a.	19.2	33.5	n.a.	28.0	n.a.
1997	% GDP	n.a.	13.2	22.2	21.1	n.a.	19.3	32.9	n.a.	26.1	n.a.
1998	% GDP	n.a.	13.1	22.2	21.6	n.a.	17.8	29.9	n.a.	26.8	n.a.
1999	% GDP	n.a.	13.8	23.4	21.7	n.a.	16.6	29.0	n.a.	26.4	n.a.
2000	% GDP	n.a.	14.4	24.3	22.2	18.2	15.4	27.9	23.7	26.5	n.a.
2001	% GDP	20.9	14.6	24.4	23.1	18.1	16.1	27.8	24.3	26.8	n.a.
2002	% GDP	23.0	16.6	24.2	22.1	17.9	15.0	23.4	24.3	28.2	30.8
2003	% GDP	25.2	17.9	23.9	21.6	18.4	15.2	21.0	24.6	27.5	32.8
2004	% GDP	26.0	14.9	22.3	21.9	18.4	14.6	19.9	25.1	27.2	31.6
2005	% GDP	26.7	14.0	23.4	21.9	19.0	15.0	20.3	26.2	26.8	31.5
2006	% GDP	28.7	14.4	25.7	22.1	20.3	16.1	19.7	26.3	26.6	31.1
2007	% GDP	29.9	14.8	27.1	20.5	20.5	15.3	22.8	26.7	27.0	29.9
2008	% GDP	28.9	14.8	24.4	19.7	19.8	15.5	23.4	28.0	29.4	30.6
2009	% GDP	29.6	14.7	23.7	23.4	18.5	14.7	19.5	27.4	29.1	33.5

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.F. Cyclically-adjusted primary budget balance as a percentage of GDP ($CAPB_t$) – developed world

	Cyclically-adjusted primary budget balance									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	0.19	-3.36	1.62	4.41	1.43	-2.45	n.a.	n.a.	-3.24
1981	% GDP	1.26	-7.15	1.15	6.64	0.32	-2.27	n.a.	n.a.	-6.11
1982	% GDP	-0.01	-2.71	-1.13	4.80	-0.42	-0.38	n.a.	n.a.	-3.21
1983	% GDP	-1.53	-3.86	2.82	3.67	0.54	0.55	n.a.	n.a.	-1.59
1984	% GDP	1.11	-0.41	6.17	5.69	0.47	1.09	n.a.	n.a.	-2.65
1985	% GDP	1.00	1.17	7.93	5.94	0.40	1.77	n.a.	0.53	-3.55
1986	% GDP	-0.19	1.53	10.28	6.31	-0.07	1.49	n.a.	1.26	-2.86
1987	% GDP	-0.03	2.95	10.18	3.52	0.92	1.13	n.a.	2.39	-3.53
1988	% GDP	0.19	2.30	9.92	5.65	-0.70	0.44	-3.93	4.98	-3.31
1989	% GDP	0.15	3.00	8.96	5.65	-0.52	2.10	-6.32	4.89	-3.22
1990	% GDP	0.34	4.06	6.89	4.54	-0.99	-0.55	-5.54	3.38	-2.16
1991	% GDP	0.02	3.10	5.54	2.07	-0.77	-2.06	-2.14	4.19	-0.45
1992	% GDP	1.45	2.28	5.30	0.05	-1.88	-0.88	-1.24	4.24	2.04
1993	% GDP	0.04	4.25	5.94	-0.52	-2.18	0.29	-0.27	5.03	3.92
1994	% GDP	-0.75	4.32	3.81	-0.37	-1.36	0.69	4.50	5.18	3.15
1995	% GDP	-1.63	4.44	3.48	-1.05	-1.38	0.10	2.45	3.13	4.38
1996	% GDP	0.01	4.86	3.76	1.28	0.55	0.37	4.12	4.31	4.98
1997	% GDP	2.03	5.13	3.90	1.96	0.97	0.90	3.41	4.14	6.89
1998	% GDP	0.96	6.30	4.01	3.65	0.76	1.18	4.28	4.84	5.49
1999	% GDP	0.50	5.54	4.69	3.27	0.62	1.55	4.31	3.48	5.28
2000	% GDP	0.67	5.31	4.34	7.58	-0.09	3.57	3.58	4.92	4.91
2001	% GDP	3.20	6.40	3.84	6.42	0.05	-0.44	1.97	1.64	2.43
2002	% GDP	2.57	5.48	3.39	5.58	-1.25	-0.67	1.09	0.56	2.22
2003	% GDP	2.31	5.52	3.30	4.21	-1.94	-0.23	-0.96	1.80	1.69
2004	% GDP	-0.94	3.93	4.32	3.28	-1.75	-0.13	-3.04	2.85	1.05
2005	% GDP	1.66	1.00	6.31	3.56	-1.10	0.47	-0.75	2.55	0.07
2006	% GDP	0.92	3.27	5.00	3.94	-0.61	1.11	-2.04	3.25	0.25
2007	% GDP	1.15	2.19	4.62	3.87	-1.07	2.17	-3.31	-0.66	2.04
2008	% GDP	0.76	1.66	4.55	3.77	-0.66	2.00	-5.64	-5.89	1.85
2009	% GDP	0.38	-0.97	2.75	1.72	-3.40	1.63	-9.86	-9.65	1.22
2010	% GDP	-0.64	-0.25	-0.92	0.65	-3.45	-0.38	-1.42	-27.20	0.95

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.F. Cyclically-adjusted primary budget balance as a percentage of GDP ($CAPB_t$) – developed world *(continued)*

	Cyclically-adjusted primary budget balance							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	n.a.	-1.83	n.a.	-4.85	n.a.	n.a.	n.a.
1981	% GDP	n.a.	-0.67	n.a.	-4.64	n.a.	n.a.	n.a.
1982	% GDP	n.a.	0.30	n.a.	-2.94	n.a.	n.a.	n.a.
1983	% GDP	n.a.	1.50	n.a.	0.14	n.a.	n.a.	n.a.
1984	% GDP	n.a.	0.95	n.a.	1.22	n.a.	n.a.	n.a.
1985	% GDP	n.a.	2.82	n.a.	-0.87	n.a.	n.a.	n.a.
1986	% GDP	n.a.	1.33	n.a.	1.56	n.a.	n.a.	1.76
1987	% GDP	n.a.	0.92	n.a.	0.39	n.a.	n.a.	1.74
1988	% GDP	n.a.	1.74	n.a.	2.73	n.a.	n.a.	2.83
1989	% GDP	n.a.	-0.11	n.a.	2.40	n.a.	n.a.	3.36
1990	% GDP	4.11	-0.99	0.07	0.38	n.a.	n.a.	1.24
1991	% GDP	-0.32	2.24	0.05	0.02	n.a.	n.a.	0.76
1992	% GDP	0.00	1.77	0.03	2.67	n.a.	n.a.	-2.14
1993	% GDP	1.82	3.94	0.04	0.19	n.a.	-1.81	-3.81
1994	% GDP	2.84	2.56	0.04	-0.16	n.a.	-0.31	-3.25
1995	% GDP	3.60	1.66	0.07	1.48	-0.21	-0.37	-2.28
1996	% GDP	3.17	3.72	0.08	0.86	1.47	4.04	-0.71
1997	% GDP	4.85	3.51	0.08	0.42	1.89	5.29	1.18
1998	% GDP	3.62	3.41	0.04	-0.94	1.00	6.32	2.94
1999	% GDP	2.27	3.62	0.07	-0.73	1.58	4.68	3.17
2000	% GDP	3.28	4.14	0.16	-1.27	1.23	6.10	5.35
2001	% GDP	4.42	2.07	0.15	-2.56	1.50	4.18	2.05
2002	% GDP	0.59	1.09	0.11	-0.69	1.82	1.52	-0.60
2003	% GDP	0.44	0.70	0.10	0.09	2.01	1.00	-2.05
2004	% GDP	-1.15	1.69	0.13	-0.41	1.65	1.24	-2.33
2005	% GDP	-0.45	2.87	0.16	-2.90	2.64	2.48	-1.98
2006	% GDP	0.56	2.75	0.20	-1.07	3.23	1.78	-1.48
2007	% GDP	1.97	1.36	0.18	-0.34	2.88	2.80	-1.50
2008	% GDP	2.58	1.85	0.20	-0.07	-2.63	2.90	-2.88
2009	% GDP	2.09	-1.20	0.13	-5.44	-7.47	2.86	-6.99
2010	% GDP	0.75	-1.92	-0.44	-3.76	-5.38	1.15	-5.66

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.G. Fiscal change as a percentage of GDP [d(CAPB)$_t$] - developed world

	Fiscal episode: Yearly change of the cyclically-adjusted primary budget balance									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1981	% GDP	1.06	-3.79	-0.47	2.23	-1.11	0.18	n.a.	n.a.	-2.87
1982	% GDP	-1.27	4.45	-2.28	-1.84	-0.74	1.89	n.a.	n.a.	2.90
1983	% GDP	-1.52	-1.15	3.95	-1.13	0.96	0.93	n.a.	n.a.	1.62
1984	% GDP	2.64	3.45	3.35	2.02	-0.06	0.55	n.a.	n.a.	-1.07
1985	% GDP	-0.11	1.58	1.75	0.25	-0.07	0.67	n.a.	n.a.	-0.90
1986	% GDP	-1.19	0.35	2.35	0.37	-0.47	-0.28	n.a.	0.73	0.69
1987	% GDP	0.16	1.42	-0.10	-2.79	0.99	-0.36	n.a.	1.13	-0.67
1988	% GDP	0.23	-0.65	-0.26	2.13	-1.62	-0.69	n.a.	2.60	0.22
1989	% GDP	-0.04	0.70	-0.96	0.00	0.18	1.66	-2.39	-0.10	0.09
1990	% GDP	0.19	1.06	-2.06	-1.12	-0.46	-2.66	0.78	-1.51	1.05
1991	% GDP	-0.32	-0.96	-1.35	-2.46	0.22	-1.51	3.41	0.82	1.71
1992	% GDP	1.43	-0.82	-0.24	-2.02	-1.11	1.19	0.90	0.05	2.49
1993	% GDP	-1.42	1.98	0.65	-0.57	-0.31	1.17	0.97	0.78	1.87
1994	% GDP	-0.79	0.07	-2.13	0.15	0.83	0.40	4.77	0.15	-0.77
1995	% GDP	-0.88	0.11	-0.33	-0.68	-0.02	-0.59	-2.05	-2.04	1.23
1996	% GDP	1.64	0.42	0.28	2.33	1.93	0.26	1.67	1.17	0.60
1997	% GDP	2.02	0.28	0.14	0.68	0.41	0.54	-0.70	-0.17	1.91
1998	% GDP	-1.07	1.17	0.11	1.69	-0.21	0.28	0.87	0.70	-1.40
1999	% GDP	-0.46	-0.76	0.69	-0.37	-0.13	0.37	0.03	-1.36	-0.21
2000	% GDP	0.17	-0.23	-0.35	4.31	-0.72	2.02	-0.73	1.45	-0.37
2001	% GDP	2.53	1.09	-0.51	-1.16	0.14	-4.01	-1.61	-3.29	-2.48
2002	% GDP	-0.62	-0.92	-0.44	-0.84	-1.30	-0.23	-0.88	-1.08	-0.21
2003	% GDP	-0.26	0.04	-0.09	-1.37	-0.69	0.44	-2.05	1.24	-0.53
2004	% GDP	-3.25	-1.59	1.02	-0.93	0.20	0.10	-2.08	1.05	-0.64
2005	% GDP	2.59	-2.93	1.99	0.27	0.64	0.59	2.30	-0.30	-0.98
2006	% GDP	-0.73	2.27	-1.31	0.38	0.49	0.64	-1.29	0.70	0.18
2007	% GDP	0.23	-1.08	-0.38	-0.07	-0.46	1.06	-1.28	-3.91	1.78
2008	% GDP	-0.39	-0.53	-0.08	-0.11	0.41	-0.17	-2.33	-5.23	-0.18
2009	% GDP	-0.38	-2.63	-1.80	-2.05	-2.73	-0.38	-4.22	-3.77	-0.63
2010	% GDP	-1.02	0.72	-3.67	-1.07	-0.05	-2.00	8.44	-17.54	-0.27

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.G. Fiscal change as a percentage of GDP [d(CAPB)t] - developed world *(continued)*

	Fiscal episode: Yearly change of the cyclically-adjusted primary budget balance							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1981	% GDP	n.a.	1.15	n.a.	0.21	n.a.	n.a.	n.a.
1982	% GDP	n.a.	0.97	n.a.	1.70	n.a.	n.a.	n.a.
1983	% GDP	n.a.	1.20	n.a.	3.08	n.a.	n.a.	n.a.
1984	% GDP	n.a.	-0.55	n.a.	1.07	n.a.	n.a.	n.a.
1985	% GDP	n.a.	1.87	n.a.	-2.09	n.a.	n.a.	n.a.
1986	% GDP	n.a.	-1.49	n.a.	2.43	n.a.	n.a.	n.a.
1987	% GDP	n.a.	-0.41	n.a.	-1.16	n.a.	n.a.	-0.02
1988	% GDP	n.a.	0.82	n.a.	2.33	n.a.	n.a.	1.10
1989	% GDP	n.a.	-1.84	n.a.	-0.33	n.a.	n.a.	0.53
1990	% GDP	n.a.	-0.88	n.a.	-2.02	n.a.	n.a.	-2.13
1991	% GDP	-4.43	3.23	-0.02	-0.36	n.a.	n.a.	-0.48
1992	% GDP	0.33	-0.48	-0.02	2.65	n.a.	n.a.	-2.89
1993	% GDP	1.82	2.18	0.01	-2.48	n.a.	n.a.	-1.68
1994	% GDP	1.02	-1.38	0.01	-0.34	n.a.	1.50	0.56
1995	% GDP	0.75	-0.90	0.02	1.64	n.a.	-0.05	0.98
1996	% GDP	-0.43	2.06	0.02	-0.62	1.68	4.41	1.56
1997	% GDP	1.69	-0.21	0.00	-0.44	0.42	1.25	1.90
1998	% GDP	-1.23	-0.10	-0.04	-1.36	-0.89	1.03	1.76
1999	% GDP	-1.35	0.21	0.03	0.21	0.58	-1.64	0.24
2000	% GDP	1.01	0.52	0.09	-0.54	-0.35	1.41	2.17
2001	% GDP	1.14	-2.07	-0.01	-1.29	0.27	-1.91	-3.29
2002	% GDP	-3.83	-0.98	-0.04	1.87	0.32	-2.67	-2.66
2003	% GDP	-0.15	-0.39	-0.01	0.79	0.19	-0.52	-1.45
2004	% GDP	-1.59	0.99	0.03	-0.50	-0.35	0.24	-0.28
2005	% GDP	0.70	1.18	0.03	-2.50	0.99	1.24	0.35
2006	% GDP	1.01	-0.12	0.04	1.83	0.59	-0.71	0.50
2007	% GDP	1.41	-1.39	-0.01	0.74	-0.35	1.02	-0.02
2008	% GDP	0.61	0.49	0.02	0.26	-5.51	0.10	-1.37
2009	% GDP	-0.49	-3.05	-0.08	-5.36	-4.84	-0.04	-4.12
2010	% GDP	-1.34	-0.71	-0.57	1.67	2.09	-1.71	1.33

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.H. Cyclically adjusted budget balance as a percentage of GDP (CAB_t) – developing world

	Cyclically-adjusted budget balance										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1980	% GDP	n.a.	n.a.	-8.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	-7.1	-11.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	-7.7	-16.1	n.a.	n.a.	n.a.	-1.3	-4.3	n.a.
1983	% GDP	n.a.	n.a.	-7.9	-19.7	n.a.	n.a.	n.a.	-1.2	-3.5	n.a.
1984	% GDP	n.a.	n.a.	-6.4	-25.4	n.a.	n.a.	n.a.	-1.8	-3.6	n.a.
1985	% GDP	n.a.	n.a.	-5.9	-9.5	n.a.	n.a.	n.a.	-1.4	-2.1	n.a.
1986	% GDP	n.a.	n.a.	-6.4	-1.5	n.a.	n.a.	n.a.	-2.4	-1.7	n.a.
1987	% GDP	n.a.	n.a.	-6.0	-6.9	n.a.	n.a.	n.a.	-2.9	-0.6	n.a.
1988	% GDP	n.a.	n.a.	-5.6	-5.8	n.a.	n.a.	n.a.	-3.2	-0.9	n.a.
1989	% GDP	n.a.	n.a.	-5.9	-5.0	n.a.	n.a.	n.a.	-2.2	-1.3	n.a.
1990	% GDP	2.5	n.a.	-5.8	-4.3	n.a.	n.a.	n.a.	-0.9	-0.3	n.a.
1991	% GDP	3.8	n.a.	-5.4	-4.4	n.a.	n.a.	n.a.	-1.1	0.7	n.a.
1992	% GDP	0.5	n.a.	-4.5	-4.2	n.a.	n.a.	n.a.	-1.9	0.1	n.a.
1993	% GDP	-5.3	n.a.	-4.4	-6.0	n.a.	n.a.	n.a.	-1.9	-0.4	n.a.
1994	% GDP	-0.5	n.a.	-4.5	-3.1	n.a.	n.a.	n.a.	-3.0	-0.7	n.a.
1995	% GDP	1.4	-25.5	-5.2	-2.1	n.a.	n.a.	n.a.	-2.4	-2.0	n.a.
1996	% GDP	4.3	-25.4	-4.3	-2.3	-6.1	n.a.	22.6	-1.9	-3.3	n.a.
1997	% GDP	3.8	-4.0	-4.0	-4.0	-6.7	n.a.	22.2	-2.1	-4.4	n.a.
1998	% GDP	-3.5	-4.5	-3.5	-6.2	-7.6	n.a.	22.2	-3.0	-4.1	n.a.
1999	% GDP	-1.8	-5.4	-3.8	-4.5	-4.7	n.a.	22.7	-3.6	-4.1	n.a.
2000	% GDP	10.5	-4.3	-5.1	-4.8	-3.4	0.5	23.9	-2.9	-2.1	-2.7
2001	% GDP	4.7	-5.2	-4.9	-7.8	-2.8	-0.4	24.2	-2.1	-2.0	-1.9
2002	% GDP	1.9	-11.0	-4.4	-9.2	-3.8	0.4	24.1	-2.1	-2.2	-2.7
2003	% GDP	4.6	-0.9	-3.2	-8.2	-3.9	0.8	23.6	-1.5	-1.0	-2.1
2004	% GDP	4.6	-0.7	-2.9	-7.2	-2.4	-1.0	24.2	-0.5	-0.3	-1.4
2005	% GDP	12.4	-0.9	-3.3	-2.2	-2.9	3.0	4.6	-0.6	0.3	-0.7
2006	% GDP	13.3	-1.2	-3.2	3.0	-3.2	32.8	7.5	-0.4	-1.2	0.1
2007	% GDP	5.8	-3.5	-3.3	0.9	-3.3	4.4	7.8	0.3	-2.1	0.8
2008	% GDP	9.1	-2.3	-5.3	-2.8	-2.6	2.3	3.7	-1.2	-0.7	0.0
2009	% GDP	-5.0	-4.6	-4.0	-4.6	-3.3	0.1	-3.8	-4.0	-2.6	-2.7

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.H. Cyclically adjusted budget balance as a percentage of GDP (CAB_t) – developing world *(continued)*

	Cyclically-adjusted budget balance									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-13.1	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-13.3	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-8.9	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-3.1	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.6	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-3.2	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.8	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.2	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-3.2	n.a.	n.a.	-6.2
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.2	n.a.	n.a.	-8.9
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-4.8	n.a.	n.a.	-9.3
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-4.0	n.a.	n.a.	-7.6
1992	% GDP	n.a.	n.a.	n.a.	n.a.	-18.1	-12.0	n.a.	n.a.	-6.6
1993	% GDP	n.a.	n.a.	n.a.	n.a.	-3.8	-13.3	n.a.	n.a.	-6.9
1994	% GDP	n.a.	n.a.	n.a.	n.a.	-2.5	-12.3	n.a.	n.a.	-6.6
1995	% GDP	n.a.	n.a.	n.a.	n.a.	-1.7	-11.0	n.a.	n.a.	-6.2
1996	% GDP	n.a.	n.a.	n.a.	n.a.	-2.0	-13.5	n.a.	n.a.	-6.6
1997	% GDP	-3.3	n.a.	n.a.	n.a.	-1.3	-15.2	n.a.	n.a.	-7.5
1998	% GDP	-3.7	n.a.	n.a.	n.a.	-1.9	-13.1	n.a.	n.a.	-8.4
1999	% GDP	-4.2	n.a.	n.a.	n.a.	-2.4	-14.0	n.a.	n.a.	-9.1
2000	% GDP	-1.6	0.9	n.a.	n.a.	-3.2	-9.7	-2.0	0.7	-9.2
2001	% GDP	0.8	1.0	0.4	n.a.	-6.2	-6.8	-2.0	-3.8	-8.9
2002	% GDP	-0.8	-2.8	1.9	-9.1	-3.6	-6.3	-1.0	-4.2	-8.3
2003	% GDP	-1.3	-3.7	2.6	-8.5	-3.9	-4.4	-2.4	-5.9	-7.7
2004	% GDP	-1.1	-1.9	2.1	-7.5	-2.5	-4.4	-0.9	-2.0	-6.4
2005	% GDP	-1.3	-0.1	0.3	-7.6	-2.8	-4.3	-1.5	-1.4	-6.0
2006	% GDP	-1.4	-1.2	3.0	-8.7	-2.6	-7.5	-1.9	-2.4	-5.3
2007	% GDP	-0.5	-0.2	2.0	-7.7	-2.3	-9.3	-1.7	-2.5	-4.7
2008	% GDP	-0.6	-4.0	-1.8	-8.5	-3.0	-15.4	-1.9	-2.6	-8.1
2009	% GDP	-2.1	-3.7	-4.2	-7.7	-5.0	-10.4	-3.1	-4.1	-10.2

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.H. Cyclically adjusted budget balance as a percentage of GDP (CAB_t) – developing world (*continued*)

	Cyclically-adjusted budget balance										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-16.0	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-13.5	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-4.0	-9.5	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.4	-8.1	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.4	-8.3	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-3.1	-3.3	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-3.5	-3.2	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.8	-2.9	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.8	-1.3	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-3.6	-5.3	n.a.	n.a.	n.a.
1990	% GDP	n.a.	-2.1	n.a.	n.a.	-3.8	-5.0	-2.0	-1.0	-3.2	-2.5
1991	% GDP	n.a.	-4.3	n.a.	2.3	-6.4	-9.0	-5.6	0.4	-1.3	-2.8
1992	% GDP	n.a.	-4.0	n.a.	2.3	1.8	-10.9	-6.4	1.1	-0.4	-2.4
1993	% GDP	n.a.	-7.6	n.a.	1.9	-2.6	-10.9	-8.0	2.2	-0.2	-1.6
1994	% GDP	n.a.	-4.2	n.a.	1.9	-3.2	-4.8	-8.7	4.3	-1.3	-4.0
1995	% GDP	n.a.	-3.0	n.a.	1.2	-3.3	0.0	-6.3	0.0	-3.2	-1.8
1996	% GDP	n.a.	-1.8	n.a.	-3.8	-4.2	-0.7	-5.0	-0.7	-4.8	0.5
1997	% GDP	n.a.	-2.5	n.a.	-5.9	-3.5	-0.8	-2.6	1.3	-5.9	2.6
1998	% GDP	n.a.	-6.5	n.a.	-5.3	-5.6	0.5	-6.7	1.3	-6.3	1.4
1999	% GDP	n.a.	0.1	n.a.	-3.4	-2.3	1.4	-3.5	-0.6	-6.3	4.1
2000	% GDP	-1.3	6.8	-4.6	-0.8	-3.0	0.1	-3.7	-4.6	-4.1	-1.2
2001	% GDP	-1.8	1.7	-4.9	-3.4	-2.1	-2.3	-5.6	-3.5	-3.6	-4.1
2002	% GDP	-0.2	0.9	-3.1	-5.7	-3.1	-1.9	-5.5	-3.6	-3.4	-3.2
2003	% GDP	-0.8	1.3	-4.8	-5.7	-0.3	-1.5	-4.6	-4.5	-1.8	-2.2
2004	% GDP	-0.1	1.6	-2.9	-4.9	0.0	0.7	-5.7	-3.5	-1.2	-1.6
2005	% GDP	0.9	1.6	-1.3	-3.7	-5.2	-1.5	-4.5	-2.9	-1.4	-3.8
2006	% GDP	0.3	-0.3	-1.2	-5.0	-4.0	-2.7	37.7	-2.3	-1.5	-1.4
2007	% GDP	-1.4	1.3	-0.9	-4.6	-5.3	-3.8	-3.0	-3.3	-2.0	1.5
2008	% GDP	-0.6	-0.3	-2.9	-6.6	-5.4	-4.3	-2.9	-4.1	-2.0	0.8
2009	% GDP	-2.0	-1.2	-5.4	-9.0	-8.4	-5.4	-2.9	-4.9	-3.5	-3.1

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.H. Cyclically adjusted budget balance as a percentage of GDP (CAB_t) – developing world (*continued*)

Cyclically-adjusted budget balance	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	1.9	n.a.	-2.7	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	17.5	0.8	4.0	n.a.	-4.2	11.8	n.a.	n.a.	n.a.
1991	% GDP	n.a.	17.3	0.5	0.3	n.a.	-2.2	11.1	n.a.	-4.2	n.a.
1992	% GDP	n.a.	15.6	-1.4	-1.2	n.a.	-1.6	12.9	n.a.	-3.5	n.a.
1993	% GDP	n.a.	-7.2	-6.3	0.6	n.a.	-1.0	17.1	n.a.	-2.7	n.a.
1994	% GDP	n.a.	-5.4	10.8	2.3	n.a.	-1.2	17.3	n.a.	-0.9	n.a.
1995	% GDP	n.a.	-5.9	7.0	-0.2	n.a.	-1.2	15.3	n.a.	-2.3	n.a.
1996	% GDP	n.a.	-6.4	1.9	-0.7	n.a.	-0.8	12.9	n.a.	-3.9	n.a.
1997	% GDP	n.a.	-5.4	-1.5	-1.7	n.a.	-1.4	15.9	n.a.	-2.5	n.a.
1998	% GDP	n.a.	-5.9	-3.3	-0.9	n.a.	-2.5	9.8	n.a.	-1.8	n.a.
1999	% GDP	n.a.	-3.7	-2.2	-3.2	n.a.	-4.0	10.8	n.a.	-2.5	n.a.
2000	% GDP	n.a.	-3.9	-1.1	-3.7	-2.7	-4.5	9.2	-1.4	-2.5	n.a.
2001	% GDP	-9.3	-2.5	-1.8	0.2	-1.9	-4.1	5.1	-0.8	-2.3	n.a.
2002	% GDP	-2.6	-3.1	-2.0	-1.7	-1.5	-4.9	4.5	-0.8	-1.6	-11.9
2003	% GDP	-1.8	0.9	-3.1	1.3	-0.8	-4.5	3.2	-1.3	-1.8	-8.1
2004	% GDP	-1.1	-2.1	-3.7	2.3	-0.3	-3.9	3.4	-0.8	-2.0	-3.5
2005	% GDP	-0.9	-4.4	-1.5	1.3	0.1	-2.9	5.8	0.0	-2.5	-0.9
2006	% GDP	1.0	-5.2	1.2	1.1	2.2	-1.4	4.8	0.4	-2.5	-1.5
2007	% GDP	1.7	-6.0	2.8	0.9	2.8	-2.0	8.7	0.3	-2.4	-3.5
2008	% GDP	-0.4	-7.5	-1.2	1.8	0.9	-1.7	4.5	-1.4	-1.1	-3.3
2009	% GDP	-1.2	-4.9	-1.9	0.7	-2.5	-3.9	-0.3	-4.6	-1.7	-3.8

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.I. Fiscal change as a percentage of GDP [$d(CAB)_t$] – developing world

	Fiscal episode: Yearly change of the cyclically-adjusted budget balance										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1981	% GDP	n.a.	n.a.	1.1	-11.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	-0.6	-4.4	n.a.	n.a.	n.a.	-1.3	-4.3	n.a.
1983	% GDP	n.a.	n.a.	-0.2	-3.6	n.a.	n.a.	n.a.	0.2	0.8	n.a.
1984	% GDP	n.a.	n.a.	1.5	-5.7	n.a.	n.a.	n.a.	-0.7	0.0	n.a.
1985	% GDP	n.a.	n.a.	0.5	15.9	n.a.	n.a.	n.a.	0.4	1.5	n.a.
1986	% GDP	n.a.	n.a.	-0.6	8.0	n.a.	n.a.	n.a.	-1.0	0.3	n.a.
1987	% GDP	n.a.	n.a.	0.4	-5.4	n.a.	n.a.	n.a.	-0.5	1.2	n.a.
1988	% GDP	n.a.	n.a.	0.5	1.1	n.a.	n.a.	n.a.	-0.3	-0.3	n.a.
1989	% GDP	n.a.	n.a.	-0.3	0.8	n.a.	n.a.	n.a.	1.0	-0.5	n.a.
1990	% GDP	2.5	n.a.	0.1	0.8	n.a.	n.a.	n.a.	1.3	1.0	n.a.
1991	% GDP	1.3	n.a.	0.4	-0.2	n.a.	n.a.	n.a.	-0.2	1.0	n.a.
1992	% GDP	-3.3	n.a.	0.9	0.2	n.a.	n.a.	n.a.	-0.8	-0.5	n.a.
1993	% GDP	-5.8	n.a.	0.1	-1.8	n.a.	n.a.	n.a.	-0.1	-0.6	n.a.
1994	% GDP	4.8	n.a.	-0.1	2.9	n.a.	n.a.	n.a.	-1.1	-0.3	n.a.
1995	% GDP	1.9	-25.5	-0.7	1.0	n.a.	n.a.	n.a.	0.6	-1.3	n.a.
1996	% GDP	2.9	0.1	0.9	-0.2	-6.1	n.a.	22.6	0.5	-1.3	n.a.
1997	% GDP	-0.5	21.4	0.3	-1.7	-0.6	n.a.	-0.3	-0.2	-1.2	n.a.
1998	% GDP	-7.2	-0.5	0.4	-2.1	-0.9	n.a.	0.0	-0.9	0.4	n.a.
1999	% GDP	1.7	-0.9	-0.2	1.6	2.9	n.a.	0.5	-0.6	-0.1	n.a.
2000	% GDP	12.2	1.1	-1.3	-0.3	1.3	0.5	1.2	0.7	2.0	-2.7
2001	% GDP	-5.7	-0.9	0.2	-3.0	0.6	-0.9	0.3	0.8	0.1	0.8
2002	% GDP	-2.8	-5.9	0.5	-1.4	-1.0	0.9	-0.2	0.1	-0.1	-0.8
2003	% GDP	2.7	10.2	1.2	1.0	-0.1	0.4	-0.5	0.5	1.1	0.6
2004	% GDP	0.0	0.2	0.3	1.0	1.5	-1.8	0.7	1.0	0.7	0.8
2005	% GDP	7.8	-0.2	-0.3	5.0	-0.5	4.0	-19.6	-0.1	0.6	0.6
2006	% GDP	0.9	-0.3	0.0	5.1	-0.3	29.8	2.9	0.2	-1.5	0.9
2007	% GDP	-7.5	-2.2	0.0	-2.1	0.0	-28.4	0.2	0.7	-0.8	0.7
2008	% GDP	3.3	1.1	-2.0	-3.7	0.7	-2.1	-4.0	-1.5	1.4	-0.8
2009	% GDP	-14.1	-2.3	1.3	-1.8	-0.7	-2.2	-7.5	-2.8	-1.9	-2.7

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.I. Fiscal change as a percentage of GDP [d(CAB)$_t$] – developing world *(continued)*

	Fiscal episode: Yearly change of the cyclically-adjusted budget balance									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-0.1	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	4.3	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	5.8	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.5	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-0.6	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.5	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.6	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-1.0	n.a.	n.a.	-6.2
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	-2.7
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-2.5	n.a.	n.a.	-0.4
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.7	n.a.	n.a.	1.6
1992	% GDP	n.a.	n.a.	n.a.	n.a.	-18.1	-8.0	n.a.	n.a.	1.0
1993	% GDP	n.a.	n.a.	n.a.	n.a.	14.4	-1.3	n.a.	n.a.	-0.3
1994	% GDP	n.a.	n.a.	n.a.	n.a.	1.3	0.9	n.a.	n.a.	0.3
1995	% GDP	n.a.	n.a.	n.a.	n.a.	0.8	1.4	n.a.	n.a.	0.5
1996	% GDP	n.a.	n.a.	n.a.	n.a.	-0.3	-2.5	n.a.	n.a.	-0.4
1997	% GDP	-3.3	n.a.	n.a.	n.a.	0.8	-1.7	n.a.	n.a.	-0.9
1998	% GDP	-0.4	n.a.	n.a.	n.a.	-0.6	2.1	n.a.	n.a.	-0.9
1999	% GDP	-0.4	n.a.	n.a.	n.a.	-0.5	-0.9	n.a.	n.a.	-0.7
2000	% GDP	2.6	0.9	n.a.	n.a.	-0.8	4.3	-2.0	0.7	-0.1
2001	% GDP	2.4	0.1	0.4	n.a.	-3.1	2.8	0.0	-4.6	0.3
2002	% GDP	-1.6	-3.7	1.5	-9.1	2.7	0.5	1.0	-0.3	0.6
2003	% GDP	-0.5	-1.0	0.7	0.6	-0.4	1.9	-1.4	-1.7	0.6
2004	% GDP	0.3	1.9	-0.5	1.0	1.5	-0.1	1.6	3.9	1.3
2005	% GDP	-0.3	1.8	-1.8	0.0	-0.4	0.2	-0.6	0.6	0.4
2006	% GDP	0.0	-1.1	2.7	-1.1	0.2	-3.3	-0.4	-1.0	0.7
2007	% GDP	0.9	1.0	-0.9	1.0	0.4	-1.8	0.2	-0.1	0.6
2008	% GDP	-0.1	-3.8	-3.9	-0.9	-0.7	-6.0	-0.1	-0.1	-3.4
2009	% GDP	-1.5	0.3	-2.3	0.8	-2.0	5.0	-1.2	-1.5	-2.1

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.I. Fiscal change as a percentage of GDP [d(CAB)$_t$] – developing world *(continued)*

	Cyclically-adjusted budget balance										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2.6	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-4.0	4.0	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.7	1.4	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-0.1	-0.2	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-0.6	5.0	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-0.4	0.1	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.7	0.3	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	1.6	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	-0.8	-4.0	n.a.	n.a.	n.a.
1990	% GDP	n.a.	-2.1	n.a.	0.0	-3.8	-1.4	3.3	-1.0	-3.2	-2.5
1991	% GDP	n.a.	-2.2	n.a.	2.3	-2.6	-4.0	-3.5	1.3	1.9	-0.3
1992	% GDP	n.a.	0.2	n.a.	0.1	8.2	-1.8	-0.9	0.7	0.8	0.4
1993	% GDP	n.a.	-3.5	n.a.	-0.4	-4.4	0.0	-1.6	1.1	0.2	0.8
1994	% GDP	n.a.	3.4	n.a.	0.0	-0.5	6.1	-0.7	2.1	-1.2	-2.5
1995	% GDP	n.a.	1.2	n.a.	-0.7	-0.2	4.9	2.5	-4.3	-1.9	2.3
1996	% GDP	n.a.	1.2	n.a.	-5.0	-0.9	-0.8	1.3	-0.8	-1.6	2.3
1997	% GDP	n.a.	-0.6	n.a.	-2.2	0.7	0.0	2.4	2.0	-1.1	2.1
1998	% GDP	n.a.	-4.1	n.a.	0.6	-2.0	1.3	-4.1	0.0	-0.4	-1.2
1999	% GDP	n.a.	6.7	n.a.	1.9	3.3	0.9	3.2	-1.8	0.0	2.7
2000	% GDP	-1.3	6.6	-4.6	2.6	-0.7	-1.4	-0.3	-4.0	2.2	-5.3
2001	% GDP	-0.5	-5.1	-0.3	-2.6	0.9	-2.4	-1.9	1.0	0.5	-2.8
2002	% GDP	1.6	-0.8	1.8	-2.3	-1.0	0.4	0.1	-0.1	0.2	0.8
2003	% GDP	-0.6	0.3	-1.6	0.0	2.9	0.4	0.9	-0.9	1.5	1.1
2004	% GDP	0.6	0.3	1.9	0.8	0.2	2.2	-1.2	0.9	0.6	0.5
2005	% GDP	1.0	0.0	1.6	1.2	-5.1	-2.2	1.2	0.6	-0.2	-2.2
2006	% GDP	-0.6	-2.0	0.1	-1.3	1.2	-1.3	42.2	0.6	-0.2	2.4
2007	% GDP	-1.8	1.7	0.2	0.3	-1.3	-1.0	-40.7	-0.9	-0.5	2.9
2008	% GDP	0.9	-1.7	-2.0	-2.0	-0.1	-0.5	0.2	-0.8	0.0	-0.7
2009	% GDP	-1.5	-0.9	-2.5	-2.4	-3.0	-1.2	0.0	-0.8	-1.5	-3.9

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.I. Fiscal change as a percentage of GDP [$d(CAB)_t$] – developing world (*continued*)

	Cyclically-adjusted budget balance										
	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	1.9	n.a.	-2.7	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	17.5	0.8	2.1	n.a.	-1.5	11.8	n.a.	n.a.	n.a.
1991	% GDP	n.a.	-0.2	-0.3	-3.7	n.a.	2.0	-0.7	n.a.	-4.2	n.a.
1992	% GDP	n.a.	-1.7	-1.9	-1.5	n.a.	0.6	1.7	n.a.	0.7	n.a.
1993	% GDP	n.a.	-22.8	-4.9	1.8	n.a.	0.6	4.3	n.a.	0.7	n.a.
1994	% GDP	n.a.	1.8	17.2	1.7	n.a.	-0.2	0.2	n.a.	1.9	n.a.
1995	% GDP	n.a.	-0.5	-3.9	-2.6	n.a.	0.1	-2.0	n.a.	-1.5	n.a.
1996	% GDP	n.a.	-0.5	-5.1	-0.5	n.a.	0.4	-2.4	n.a.	-1.5	n.a.
1997	% GDP	n.a.	1.1	-3.4	-1.0	n.a.	-0.6	3.0	n.a.	1.3	n.a.
1998	% GDP	n.a.	-0.6	-1.9	0.8	n.a.	-1.1	-6.2	n.a.	0.7	n.a.
1999	% GDP	n.a.	2.2	1.1	-2.3	n.a.	-1.5	1.1	n.a.	-0.7	n.a.
2000	% GDP	n.a.	-0.2	1.1	-0.5	-2.7	-0.5	-1.6	-1.4	0.0	n.a.
2001	% GDP	-9.3	1.4	-0.6	3.9	0.9	0.4	-4.1	0.6	0.2	n.a.
2002	% GDP	6.7	-0.6	-0.2	-2.0	0.4	-0.8	-0.5	0.0	0.7	-11.9
2003	% GDP	0.9	4.0	-1.1	3.1	0.7	0.4	-1.4	-0.5	-0.2	3.7
2004	% GDP	0.7	-2.9	-0.6	1.0	0.5	0.5	0.3	0.5	-0.3	4.6
2005	% GDP	0.2	-2.3	2.1	-1.0	0.4	1.0	2.4	0.9	-0.4	2.7
2006	% GDP	1.8	-0.8	2.7	-0.2	2.0	1.5	-1.0	0.3	-0.1	-0.7
2007	% GDP	0.7	-0.8	1.5	-0.2	0.6	-0.5	3.9	-0.1	0.1	-1.9
2008	% GDP	-2.1	-1.5	-3.9	0.8	-1.9	0.3	-4.1	-1.7	1.3	0.2
2009	% GDP	-0.8	2.5	-0.7	-1.1	-3.5	-2.2	-4.8	-3.2	-0.6	-0.6

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.J. Numerical fiscal rules (Index of fiscal rules)

Country	1980-1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	-0.2	-0.2	-0.2	0.3	0.8	0.8	1.0	1.0	1.0	1.0	0.7	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Denmark	-1.0	-1.0	-1.0	0.5	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Finland	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	0.6	0.6	0.6	0.6	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4	0.9
France	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	0.7	0.8
Germany	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Greece	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Ireland	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-0.9	-0.9	-0.9	-0.9	-0.5	-0.5	-0.5	-0.5	-0.5
Italy	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-0.5	-0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5
Luxembourg	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Netherlands	-1.0	-1.0	-1.0	-1.0	-1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Portugal	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-0.8	-0.7	-0.7	-0.7	-0.7	-0.5	-0.5
Spain	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	1.0	1.6	1.6	1.6	1.7	1.7	1.7
Sweden	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	0.4	0.4	0.4	0.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.4	1.4
United Kingdom	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1

Source: European Commission, Directorate-General for Economic and Financial Affairs. 1980-1989 data was assumed equal to the average of 1990-1991

Appendix 5.K. Expenditure composition variable – developed world

	Expenditure composition variable: extent of expenditures' cuts in the fiscal									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1981	% GDP	n.a.	0.69	n.a.	n.a.	n.a.	0.25	n.a.	n.a.	0.00
1982	% GDP	n.a.	n.a.	0.45	n.a.	0.00	1.00	n.a.	n.a.	0.00
1983	% GDP	0.11	0.93	0.75	0.08	n.a.	1.00	n.a.	n.a.	n.a.
1984	% GDP	n.a.	0.85	0.71	0.00	n.a.	0.92	n.a.	n.a.	n.a.
1985	% GDP	n.a.	1.00	0.84	0.00	n.a.	n.a.	n.a.	0.00	0.00
1986	% GDP	0.35	0.87	n.a.	n.a.	0.63	n.a.	n.a.	1.00	n.a.
1987	% GDP	1.00	n.a.	n.a.	0.52	n.a.	n.a.	n.a.	0.95	0.00
1988	% GDP	n.a.	1.00	n.a.	1.00	1.00	0.87	n.a.	n.a.	0.00
1989	% GDP	1.00	0.48	n.a.	n.a.	n.a.	n.a.	0.00	n.a.	0.00
1990	% GDP	n.a.	n.a.	n.a.	n.a.	0.00	n.a.	0.82	0.00	0.11
1991	% GDP	0.00	n.a.	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00
1992	% GDP	n.a.	0.00	0.00	n.a.	n.a.	0.00	0.00	0.00	0.00
1993	% GDP	n.a.	1.00	n.a.	1.00	0.98	0.68	0.63	0.84	n.a.
1994	% GDP	n.a.	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.97
1995	% GDP	0.19	0.00	0.23	0.65	0.07	0.00	0.56	1.00	0.00
1996	% GDP	0.99	1.00	1.00	1.00	0.57	1.00	n.a.	n.a.	0.00
1997	% GDP	n.a.	0.42	0.00	1.00	n.a.	0.92	0.00	1.00	n.a.
1998	% GDP	n.a.	n.a.	0.49	n.a.	n.a.	0.00	0.00	n.a.	n.a.
1999	% GDP	1.00	n.a.	n.a.	0.71	n.a.	1.00	n.a.	1.00	n.a.
2000	% GDP	0.20	0.00	n.a.	n.a.	1.00	n.a.	n.a.	n.a.	n.a.
2001	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2002	% GDP	n.a.	0.00	n.a.	n.a.	n.a.	0.00	n.a.	0.14	n.a.
2003	% GDP	n.a.	n.a.	0.06	n.a.	0.00	1.00	n.a.	0.00	n.a.
2004	% GDP	1.00	n.a.	0.57	0.00	0.00	0.44	0.59	n.a.	n.a.
2005	% GDP	n.a.	1.00	n.a.	1.00	1.00	1.00	n.a.	0.00	0.00
2006	% GDP	1.00	n.a.	n.a.	n.a.	n.a.	1.00	n.a.	n.a.	0.66
2007	% GDP	n.a.	n.a.	n.a.	n.a.	0.00	n.a.	n.a.	n.a.	n.a.
2008	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.
2009	% GDP	n.a.	1.00	n.a.	n.a.	n.a.	n.a.	0.49	n.a.	n.a.
2010	% GDP	0.96	1.00	n.a.	0.86	0.35	1.00	0.21	1.00	1.00

Source: Own calculations. n.a. stands for 'not applicable' or 'not available'.

Appendix 5.K. Expenditure composition variable – developed world *(continued)*

	Expenditure composition variable: extent of expenditures' cuts in the fiscal adjustment							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1981	% GDP	n.a.	0.00	n.a.	0.00	n.a.	n.a.	n.a.
1982	% GDP	n.a.	0.37	n.a.	0.54	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	0.72	n.a.	n.a.	n.a.
1984	% GDP	n.a.	0.60	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	0.04	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	1.00	n.a.	0.22	n.a.	n.a.	1.00
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.92
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	0.10	n.a.	n.a.	n.a.	n.a.	n.a.
1991	% GDP	0.00	n.a.	n.a.	0.00	n.a.	n.a.	n.a.
1992	% GDP	0.15	0.05	1.00	n.a.	n.a.	n.a.	n.a.
1993	% GDP	0.83	n.a.	0.96	n.a.	n.a.	1.00	1.00
1994	% GDP	0.00	n.a.	1.00	0.25	n.a.	n.a.	0.80
1995	% GDP	n.a.	0.86	1.00	n.a.	0.79	0.49	1.00
1996	% GDP	0.27	n.a.	n.a.	n.a.	1.00	1.00	0.92
1997	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.00	0.53
1998	% GDP	n.a.	0.32	0.39	0.00	0.75	n.a.	0.00
1999	% GDP	1.00	1.00	0.58	n.a.	n.a.	1.00	0.92
2000	% GDP	0.00	n.a.	n.a.	n.a.	1.00	n.a.	n.a.
2001	% GDP	n.a.	n.a.	n.a.	0.05	0.00	n.a.	n.a.
2002	% GDP	n.a.	n.a.	n.a.	0.00	0.95	n.a.	n.a.
2003	% GDP	n.a.	0.81	0.91	n.a.		1.00	n.a.
2004	% GDP	1.00	0.95	0.91	n.a.	0.18	0.26	0.00
2005	% GDP	1.00	n.a.	0.55	0.79	0.00	n.a.	0.00
2006	% GDP	1.00	n.a.	n.a.	1.00	n.a.	1.00	n.a.
2007	% GDP	0.00	0.00	0.29	1.00	n.a.	0.00	n.a.
2008	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2009	% GDP	n.a.	n.a.	n.a.	0.00	0.16	n.a.	0.95
2010	% GDP	0.70	0.56	1.00	0.91	0.93	n.a.	1.00

Source: Own calculations. n.a. stands for 'not applicable' or 'not available'.

Appendix 5.L. Expenditure composition variable – developing world

	Expenditure composition variable: extent of expenditures' cuts in the fiscal adjustment										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1981	% GDP	n.a.	n.a.	0.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	0.0	n.a.
1984	% GDP	n.a.	n.a.	1.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	0.3	0.5	n.a.	n.a.	n.a.	1.0	0.4	n.a.
1986	% GDP	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	n.a.	1.0	n.a.
1987	% GDP	n.a.	n.a.	1.0	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.
1988	% GDP	n.a.	n.a.	0.5	0.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	0.0	n.a.	n.a.
1990	% GDP	0.0	n.a.	1.0	1.0	n.a.	n.a.	n.a.	0.3	0.3	n.a.
1991	% GDP	0.0	n.a.	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.
1992	% GDP	n.a.	n.a.	0.0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1993	% GDP	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1994	% GDP	0.4	n.a.	n.a.	0.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1995	% GDP	0.9	n.a.	n.a.	1.0	n.a.	n.a.	n.a.	1.0	n.a.	n.a.
1996	% GDP	0.4	1.0	1.0	n.a.	n.a.	n.a.	0.0	0.8	n.a.	n.a.
1997	% GDP	n.a.	0.0	0.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1998	% GDP	n.a.	n.a.	0.7	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.
1999	% GDP	0.0	n.a.	n.a.	0.2	0.6	n.a.	0.0	n.a.	n.a.	n.a.
2000	% GDP	0.3	0.2	n.a.	n.a.	1.0	0.0	0.0	0.0	0.8	n.a.
2001	% GDP	n.a.	n.a.	0.0	n.a.	0.0	n.a.	0.0	0.0	0.0	0.0
2002	% GDP	n.a.	n.a.	0.0	n.a.	n.a.	1.0	n.a.	0.0	n.a.	n.a.
2003	% GDP	0.8	0.8	0.9	1.0	n.a.	0.8	n.a.	0.5	0.4	1.0
2004	% GDP	n.a.	0.0	1.0	0.0	1.0	n.a.	0.0	0.5	1.0	1.0
2005	% GDP	0.5	n.a.	n.a.	0.0	n.a.	0.3	n.a.	n.a.	0.5	0.9
2006	% GDP	0.0	n.a.	0.0	0.4	n.a.	0.0	0.5	0.0	n.a.	1.0
2007	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.		0.0	0.0	n.a.	0.3
2008	% GDP	0.0	0.0	n.a.	n.a.	0.5	n.a.	n.a.	n.a.	1.0	n.a.
2009	% GDP	n.a.	n.a.	1.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Own calculation. 'n.a.' stands for 'not applicable' or 'not available'.

Appendix 5.L. Expenditure composition variable – developing world *(continued)*

	Expenditure composition variable: extent of expenditures' cuts in the fiscal adjustment									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1992	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	0.4
1993	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.8
1994	% GDP	n.a.	n.a.	n.a.	n.a.	0.1	n.a.	n.a.	n.a.	n.a.
1995	% GDP	n.a.	n.a.	n.a.	n.a.	0.3	0.0	n.a.	n.a.	0.4
1996	% GDP	n.a.	n.a.	n.a.	n.a.	0.2	0.0	n.a.	n.a.	1.0
1997	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1998	% GDP	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.	n.a.
1999	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.2	n.a.	n.a.	n.a.
2000	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2001	% GDP	0.5	0.0	n.a.	n.a.	n.a.	0.0	n.a.	0.0	n.a.
2002	% GDP	0.6	0.0	0.0	n.a.	n.a.	0.0	0.0	n.a.	0.0
2003	% GDP	n.a.	n.a.	0.2	n.a.	1.0	1.0	0.6	n.a.	0.0
2004	% GDP	n.a.	n.a.	1.0	0.0	n.a.	0.0	n.a.	n.a.	0.4
2005	% GDP	0.0	0.2	n.a.	1.0	0.6	n.a.	1.0	0.4	0.6
2006	% GDP	n.a.	0.4	n.a.	n.a.	n.a.	1.0	n.a.	1.0	1.0
2007	% GDP	n.a.	n.a.	0.0	n.a.	0.0	n.a.	n.a.	n.a.	0.2
2008	% GDP	0.4	0.5		1.0	1.0	n.a.	1.0	n.a.	0.0
2009	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
		n.a.	1.0		1.0	n.a.	1.0	n.a.	n.a.	n.a.

Source: Own calculation. 'n.a.' stands for 'not applicable' or 'not available'.

Appendix 5.L. Expenditure composition variable – developing world (*continued*)

	Expenditure composition variable: extent of expenditures' cuts in the fiscal adjustment										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	1.0	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.6	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	1.0	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.8	n.a.	n.a.	n.a.
1991	% GDP	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	1.0	1.0	n.a.
1992	% GDP	n.a.	0.0	n.a.	1.0	1.0	n.a.	n.a.	0.0	1.0	0.0
1993	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	0.7	0.0
1994	% GDP	n.a.	1.0	n.a.	n.a.	n.a.	0.0	n.a.	0.6	n.a.	n.a.
1995	% GDP	n.a.	1.0	n.a.	n.a.	n.a.	0.4	0.9	n.a.	n.a.	0.2
1996	% GDP	n.a.	1.0	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	1.0
1997	% GDP	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	0.2	1.0	n.a.	0.0
1998	% GDP	n.a.	n.a.	n.a.	0.0	n.a.	0.7	n.a.	1.0	n.a.	n.a.
1999	% GDP	n.a.	0.2	n.a.	0.0	0.7	1.0	0.7	n.a.	n.a.	0.1
2000	% GDP	n.a.	0.5	n.a.	0.7	n.a.	n.a.	n.a.	n.a.	1.0	n.a.
2001	% GDP	n.a.	n.a.	n.a.	n.a.	0.6	n.a.	n.a.	0.0	0.0	n.a.
2002	% GDP	1.0	n.a.	0.0	n.a.	n.a.	0.0	1.0	n.a.	0.0	1.0
2003	% GDP	n.a.	0.0	n.a.	n.a.	0.0	0.3	0.0	n.a.	0.4	1.0
2004	% GDP	0.0	0.0	1.0	0.0	0.0	0.3	n.a.	1.0	1.0	0.0
2005	% GDP	1.0	0.0	1.0	1.0	n.a.	n.a.	1.0	1.0	n.a.	n.a.
2006	% GDP	n.a.	n.a.	1.0	n.a.	1.0	n.a.	0.0	0.0	n.a.	0.8
2007	% GDP		0.9	1.0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	0.1
2008	% GDP	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	0.3	n.a.	0.0	n.a.
2009	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Own calculation. 'n.a.' stands for 'not applicable' or 'not available'.

Appendix 5.L. Expenditure composition variable – developing world (*continued*)

	Expenditure composition variable: extent of expenditures' cuts in the fiscal adjustment										
	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	0.0	0.0	0.7	n.a.	n.a.	0.0	n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.3	n.a.	n.a.	n.a.	n.a.
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	0.2	n.a.	1.0	n.a.
1992	% GDP	n.a.	n.a.	n.a.	0.2	n.a.	1.0	0.6	n.a.	0.0	n.a.
1993	% GDP	n.a.	1.0	1.0	0.0	n.a.	n.a.	1.0	n.a.	0.3	n.a.
1994	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.	n.a.
1995	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.	n.a.	n.a.	n.a.
1996	% GDP	n.a.	1.0	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	1.0	n.a.
1997	% GDP	n.a.	n.a.	n.a.	0.3	n.a.	n.a.	n.a.	n.a.	0.1	n.a.
1998	% GDP	n.a.	0.7	0.0	n.a.	n.a.	n.a.	1.0	n.a.	n.a.	n.a.
1999	% GDP	n.a.	n.a.	0.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2000	% GDP	n.a.	0.9	n.a.	0.8	1.0	0.0	n.a.	0.0	0.0	n.a.
2001	% GDP	0.7	n.a.	n.a.	n.a.	1.0		n.a.	0.3	0.0	n.a.
2002	% GDP	0.0	0.7	n.a.	1.0	0.2	0.6	n.a.	n.a.	n.a.	0.4
2003	% GDP	0.0	n.a.	n.a.	0.7	1.0	1.0	1.0	0.0	n.a.	1.0
2004	% GDP	0.0	n.a.	0.5	n.a.	0.0	0.6	0.8	0.0	n.a.	1.0
2005	% GDP	0.0	n.a.	0.2	n.a.	0.4	0.3	n.a.	0.5	n.a.	n.a.
2006	% GDP	0.0	n.a.	0.1	n.a.	0.7	n.a.	0.2	n.a.	0.0	n.a.
2007	% GDP	n.a.	n.a.	n.a.	1.0		0.5	n.a.	n.a.	0.0	0.0
2008	% GDP	n.a.	1.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2009	% GDP										

Source: Own calculation. 'n.a.' stands for 'not applicable' or 'not available'.

Appendix 5.M. Output gap between actual and potential gross domestic product - developed world

Output gap between actual and potential gross domestic product at 2000 market prices										
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	1.34	0.63	-0.33	0.95	-0.69	0.02	3.05	1.39	1.81
1981	% GDP	-0.88	-0.46	-3.41	-0.77	-1.79	0.01	0.37	0.93	0.86
1982	% GDP	-0.72	-0.83	-2.47	-1.04	-1.21	-0.02	-1.45	-0.18	-0.56
1983	% GDP	0.49	-2.02	-2.51	-1.44	-1.65	-0.02	-3.21	-3.45	-1.64
1984	% GDP	-1.19	-1.26	-1.19	-1.66	-1.81	-0.01	-1.92	-2.82	-1.04
1985	% GDP	-0.63	-1.59	0.05	-1.51	-1.81	-0.01	0.11	-3.00	-0.96
1986	% GDP	-0.29	-1.72	2.18	-1.50	-1.26	-0.01	0.16	-5.22	-0.73
1987	% GDP	-1.09	-1.55	0.20	-0.51	-1.04	-0.02	-2.59	-3.44	-0.19
1988	% GDP	-0.70	0.48	-1.58	2.45	0.93	0.00	0.58	-2.08	1.23
1989	% GDP	0.18	1.18	-2.50	5.41	2.43	0.00	3.03	0.42	2.08
1990	% GDP	1.27	1.69	-2.63	4.43	2.58	0.02	1.47	3.57	1.71
1991	% GDP	1.50	1.33	-3.19	-2.18	1.38	3.85	2.86	1.17	0.86
1992	% GDP	0.61	0.85	-3.16	-5.55	0.70	3.09	1.90	-0.27	-0.39
1993	% GDP	-1.22	-1.86	-4.93	-6.30	-1.96	-0.18	-1.29	-2.40	-2.50
1994	% GDP	-1.00	-0.52	-1.66	-4.01	-1.52	0.38	-1.04	-2.37	-1.76
1995	% GDP	-0.34	-0.17	-0.77	-2.19	-1.25	0.38	-0.84	0.24	-0.42
1996	% GDP	-0.26	-0.79	-0.17	-1.15	-1.97	-0.41	-0.77	0.20	-0.83
1997	% GDP	-0.47	0.58	0.80	1.51	-1.60	-0.31	-0.04	2.50	-0.52
1998	% GDP	0.58	0.17	0.71	2.63	-0.07	0.01	0.13	2.01	-0.74
1999	% GDP	1.31	1.23	1.08	2.49	1.22	0.26	-0.01	3.70	-0.81
2000	% GDP	2.34	2.34	2.34	3.91	3.05	1.70	0.16	4.48	1.18
2001	% GDP	0.41	0.82	1.18	2.38	2.94	1.32	0.11	1.99	1.58
2002	% GDP	-0.20	0.23	0.07	0.95	2.13	-0.12	-0.80	1.23	0.87
2003	% GDP	-1.67	-0.68	-0.81	-0.06	1.34	-1.64	0.52	-0.34	-0.13
2004	% GDP	-1.30	0.82	0.20	1.15	1.82	-1.63	1.09	-0.81	0.37
2005	% GDP	-0.90	0.75	1.21	1.28	1.65	-1.93	0.07	0.48	0.50
2006	% GDP	0.70	1.58	2.79	3.01	1.79	0.22	1.51	1.74	2.07
2007	% GDP	2.48	2.44	2.71	5.52	2.09	1.69	3.17	4.30	2.89
2008	% GDP	2.80	1.47	0.20	3.69	0.43	1.57	2.56	-0.10	1.21
2009	% GDP	-2.54	-2.62	-5.61	-6.05	-3.64	-4.06	-0.49	-6.40	-3.67
2010	% GDP	-1.84	-2.04	-3.61	-4.95	-3.47	-1.69	-5.20	-5.23	-2.61

Source: AMECO database.

Appendix 5.M. Output gap between actual and potential gross domestic product developed world *(continued)*

	Output gap between actual and potential gross domestic product at 2000 market prices							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	n.a.	2.48	0.02	1.11	-1.54	1.38	-0.47
1981	% GDP	n.a.	0.22	0.00	0.89	-2.86	-1.26	-2.65
1982	% GDP	-2.19	-2.16	-0.03	0.84	-2.95	-2.32	-1.96
1983	% GDP	-2.66	-2.19	-0.02	-0.20	-2.88	-2.76	-0.53
1984	% GDP	-0.95	-0.43	0.01	-3.15	-2.80	-1.05	-0.67
1985	% GDP	-2.39	-0.37	0.03	-3.85	-2.79	-1.18	0.08
1986	% GDP	1.24	0.36	0.04	-3.59	-2.41	-0.50	0.95
1987	% GDP	-1.29	-0.30	0.03	-0.49	-0.36	0.63	2.26
1988	% GDP	0.15	0.10	0.00	-0.09	1.07	1.10	4.03
1989	% GDP	2.81	1.35	-0.02	1.44	2.11	1.61	3.26
1990	% GDP	1.50	2.34	-0.03	4.31	2.34	0.67	1.47
1991	% GDP	3.41	1.70	-0.03	3.14	1.56	-1.72	-1.80
1992	% GDP	0.52	0.47	-0.02	2.16	-0.36	-3.81	-3.23
1993	% GDP	0.11	-1.00	-0.03	-1.34	-3.49	-6.46	-2.75
1994	% GDP	0.16	-0.87	-0.02	-2.38	-3.27	-4.49	-0.72
1995	% GDP	-1.67	-0.61	-0.01	-2.49	-2.77	-2.98	-0.16
1996	% GDP	-3.44	-0.53	0.01	-1.52	-2.62	-3.43	0.04
1997	% GDP	-1.66	0.30	0.03	-0.17	-1.38	-2.96	0.49
1998	% GDP	0.34	0.68	0.02	1.43	-0.03	-1.54	0.98
1999	% GDP	3.16	1.85	0.01	2.35	1.15	0.17	1.34
2000	% GDP	6.46	2.60	0.01	3.19	2.36	1.65	2.19
2001	% GDP	4.08	1.54	0.01	2.55	2.07	0.24	1.78
2002	% GDP	3.59	-0.71	0.00	1.18	0.98	0.09	1.23
2003	% GDP	0.51	-2.28	-0.02	-1.17	0.31	-0.05	1.48
2004	% GDP	0.45	-1.76	0.00	-0.98	0.08	1.70	1.93
2005	% GDP	1.24	-1.44	0.01	-1.19	0.26	2.28	1.54
2006	% GDP	1.98	-0.06	0.01	-0.73	0.99	3.74	1.91
2007	% GDP	3.99	1.82	0.02	0.79	1.46	4.30	2.30
2008	% GDP	1.45	1.64	0.00	0.07	0.15	1.64	0.40
2009	% GDP	-4.95	-3.62	-0.03	-2.48	-4.40	-4.96	-5.54
2010	% GDP	-4.37	-3.18	n.a.	-1.44	-4.51	-1.96	-4.98

Source: AMECO database.

Appendix 5.N. Output gap between actual and potential gross domestic product – developing world

	Output gap between actual and potential gross domestic product at constant prices										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1980	% GDP	-0.04	0.06	0.02	0.05	0.07	-0.16	0.13	0.16	0.04	0.10
1981	% GDP	-0.05	0.00	0.01	0.06	0.00	-0.06	0.17	0.05	0.03	0.05
1982	% GDP	-0.02	-0.03	0.00	0.03	-0.02	-0.03	-0.01	0.00	0.00	-0.05
1983	% GDP	0.01	0.01	0.01	-0.01	-0.08	0.00	-0.07	-0.02	-0.02	-0.04
1984	% GDP	0.03	0.03	0.01	-0.01	-0.05	0.04	-0.04	0.01	-0.03	0.00
1985	% GDP	0.07	-0.05	0.01	-0.03	0.00	0.10	-0.06	0.04	-0.03	-0.03
1986	% GDP	0.04	0.02	0.01	-0.06	0.04	0.16	-0.06	0.02	-0.02	-0.01
1987	% GDP	0.02	0.03	0.00	-0.05	0.06	0.13	-0.05	0.04	0.00	0.00
1988	% GDP	-0.01	0.00	-0.01	-0.04	0.04	0.04	-0.04	0.05	0.00	-0.01
1989	% GDP	0.02	-0.09	-0.01	-0.02	0.05	0.03	-0.01	0.00	-0.01	0.00
1990	% GDP	0.03	-0.12	0.00	-0.01	-0.02	-0.02	-0.04	-0.05	0.00	-0.01
1991	% GDP	0.00	-0.06	0.00	0.01	-0.03	-0.04	-0.04	-0.06	-0.02	-0.03
1992	% GDP	0.01	0.01	0.00	-0.01	-0.05	-0.06	0.01	-0.03	-0.01	0.00
1993	% GDP	-0.02	0.04	0.00	0.00	-0.03	-0.08	0.00	0.01	0.01	0.03
1994	% GDP	-0.05	0.07	0.00	0.00	0.01	-0.10	-0.01	0.03	0.03	0.02
1995	% GDP	-0.03	0.01	0.00	0.01	0.02	-0.08	0.03	0.04	0.05	0.01
1996	% GDP	-0.01	0.03	0.00	0.02	0.02	-0.05	0.05	0.04	0.04	-0.03
1997	% GDP	-0.02	0.09	0.00	0.03	0.03	-0.02	0.06	0.03	0.05	-0.02
1998	% GDP	0.00	0.11	0.00	0.04	0.01	0.00	0.04	0.01	0.03	0.01
1999	% GDP	0.00	0.05	0.00	0.01	-0.02	0.01	-0.01	-0.01	-0.03	0.05
2000	% GDP	-0.02	0.03	0.00	0.00	0.00	0.01	-0.01	-0.03	-0.03	0.02
2001	% GDP	-0.03	-0.04	-0.01	-0.01	-0.01	0.02	-0.01	-0.04	-0.04	-0.02
2002	% GDP	-0.02	-0.16	-0.02	-0.02	-0.02	0.02	-0.03	-0.05	-0.05	-0.04
2003	% GDP	0.01	-0.12	-0.02	-0.03	-0.03	0.02	-0.03	-0.05	-0.04	-0.02
2004	% GDP	0.02	-0.07	-0.01	-0.02	-0.01	0.02	-0.01	-0.05	-0.03	-0.03
2005	% GDP	0.03	-0.03	-0.01	-0.02	-0.01	0.01	0.00	-0.04	-0.02	-0.02
2006	% GDP	0.02	0.01	0.00	-0.01	-0.01	0.01	0.01	-0.01	0.02	0.02
2007	% GDP	0.01	0.04	0.01	0.00	0.02	0.01	0.02	0.03	0.04	0.05
2008	% GDP	0.00	0.07	0.02	0.02	0.04	0.00	0.02	0.04	0.03	0.03
2009	% GDP	-0.01	0.03	0.02	0.02	0.00	-0.01	-0.02	0.05	0.00	-0.02

Source: Own calculation.

Appendix 5.N. Output gap between actual and potential gross domestic product – developing world *(continued)*

	Output gap between actual and potential gross domestic product at constant prices									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1980	% GDP	0.01	0.00	0.01	0.00	0.10	0.03	0.05	0.04	0.03
1981	% GDP	0.04	0.02	0.03	-0.04	0.04	0.10	0.05	0.04	0.02
1982	% GDP	0.03	0.01	0.02	-0.03	-0.03	0.01	0.01	0.00	0.00
1983	% GDP	0.00	0.03	-0.03	-0.01	-0.01	-0.07	-0.02	-0.04	0.01
1984	% GDP	-0.03	0.02	-0.01	0.01	-0.01	-0.04	-0.02	-0.02	0.00
1985	% GDP	-0.01	-0.03	0.01	0.04	-0.01	-0.02	-0.03	-0.01	0.00
1986	% GDP	0.02	-0.02	0.02	0.04	-0.02	-0.03	-0.04	-0.03	-0.01
1987	% GDP	0.00	0.04	-0.07	0.04	-0.02	-0.02	-0.03	0.00	-0.02
1988	% GDP	0.00	0.03	0.01	0.04	-0.03	0.02	-0.01	0.01	0.01
1989	% GDP	0.00	0.04	-0.02	0.03	-0.05	0.02	0.00	0.02	0.02
1990	% GDP	-0.03	-0.05	-0.01	0.02	-0.04	0.01	0.00	-0.01	0.03
1991	% GDP	-0.06	-0.07	0.01	0.00	-0.05	0.01	0.00	-0.01	0.00
1992	% GDP	-0.09	-0.02	0.02	-0.03	-0.02	0.01	0.01	0.01	-0.02
1993	% GDP	0.00	0.00	0.01	-0.03	0.01	0.01	0.00	0.04	-0.02
1994	% GDP	-0.04	-0.03	0.04	-0.03	0.02	0.00	0.00	0.00	-0.02
1995	% GDP	-0.02	-0.02	0.02	-0.03	0.04	0.00	0.01	0.00	-0.01
1996	% GDP	0.03	-0.01	0.02	-0.03	0.02	0.00	0.00	0.01	0.01
1997	% GDP	0.06	0.01	0.03	-0.01	0.02	0.00	0.00	0.02	0.05
1998	% GDP	0.08	0.03	0.02	0.01	0.02	0.00	0.01	0.02	0.04
1999	% GDP	0.08	0.04	-0.06	0.02	0.02	0.00	0.01	-0.04	0.01
2000	% GDP	0.02	0.04	-0.05	0.03	0.01	-0.01	0.00	-0.02	-0.01
2001	% GDP	0.01	0.01	-0.03	0.01	0.00	-0.02	-0.01	-0.03	-0.03
2002	% GDP	-0.02	0.01	-0.04	0.00	-0.01	-0.02	0.00	-0.03	-0.05
2003	% GDP	-0.04	-0.04	-0.04	-0.02	-0.01	-0.02	-0.01	-0.03	-0.05
2004	% GDP	-0.03	-0.08	0.00	-0.03	-0.02	-0.02	-0.02	-0.02	-0.04
2005	% GDP	-0.02	-0.05	0.02	-0.03	-0.01	-0.01	-0.02	0.00	-0.02
2006	% GDP	-0.02	0.00	0.02	-0.02	0.00	0.00	0.00	0.02	0.00
2007	% GDP	-0.01	0.03	0.01	0.00	0.02	0.00	0.02	0.04	0.03
2008	% GDP	0.00	0.03	0.03	0.03	0.02	0.03	0.02	0.04	0.03
2009	% GDP	0.03	0.02	0.00	0.03	-0.03	0.02	0.00	-0.02	0.03

Source: Own calculation.

Appendix 5.N. Output gap between actual and potential gross domestic product – developing world (*continued*)

	Output gap between actual and potential gross domestic product at constant prices										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1980	% GDP	0.05	-0.10	0.04	-0.01	-0.11	0.01	0.09	0.06	-0.02	0.04
1981	% GDP	0.05	-0.06	0.04	0.00	0.02	0.01	-0.02	0.06	0.05	-0.03
1982	% GDP	0.01	0.04	0.02	0.00	0.07	0.01	-0.04	0.05	0.03	0.02
1983	% GDP	-0.01	0.11	0.00	0.01	0.02	-0.02	-0.03	0.05	-0.01	-0.03
1984	% GDP	0.00	0.12	-0.01	-0.01	0.05	-0.04	-0.02	0.06	0.01	-0.03
1985	% GDP	-0.03	0.14	-0.01	-0.05	0.00	-0.04	-0.02	-0.01	0.02	-0.01
1986	% GDP	-0.03	0.01	-0.02	-0.01	0.05	-0.02	-0.01	-0.07	-0.03	0.03
1987	% GDP	-0.04	-0.03	0.01	0.04	0.06	0.00	-0.01	-0.08	-0.03	-0.03
1988	% GDP	-0.05	-0.18	0.00	-0.03	0.06	0.03	0.02	-0.06	-0.04	0.03
1989	% GDP	-0.03	-0.15	-0.04	0.00	-0.07	0.04	0.05	-0.05	-0.02	0.02
1990	% GDP	-0.02	-0.02	-0.02	0.02	-0.09	0.05	0.07	-0.04	0.00	0.03
1991	% GDP	-0.01	0.07	-0.03	0.02	-0.10	0.04	-0.01	-0.03	0.02	0.07
1992	% GDP	-0.01	0.08	-0.01	0.02	0.00	0.00	-0.01	-0.02	0.03	0.00
1993	% GDP	0.01	0.03	-0.03	0.02	0.01	-0.02	-0.01	0.00	0.02	-0.04
1994	% GDP	0.04	-0.01	-0.02	0.02	0.03	-0.02	-0.02	0.02	0.03	0.04
1995	% GDP	0.07	-0.02	0.03	0.02	0.05	0.00	-0.02	0.05	-0.06	-0.06
1996	% GDP	0.12	0.01	0.03	0.01	0.03	0.02	-0.02	0.08	-0.04	0.03
1997	% GDP	0.13	0.01	0.02	-0.01	0.02	0.00	-0.01	0.10	-0.01	-0.03
1998	% GDP	-0.05	-0.01	0.01	-0.03	0.00	0.00	0.00	-0.04	0.00	0.01
1999	% GDP	-0.07	-0.03	0.01	-0.02	-0.02	0.00	0.02	-0.03	0.01	-0.02
2000	% GDP	-0.05	-0.03	0.06	-0.02	-0.03	-0.02	0.04	0.01	0.04	-0.04
2001	% GDP	-0.05	-0.04	0.02	-0.02	-0.03	0.00	0.07	-0.04	0.01	-0.01
2002	% GDP	-0.04	-0.02	-0.02	-0.02	-0.03	-0.03	-0.09	-0.03	-0.01	-0.02
2003	% GDP	-0.03	0.00	-0.04	0.00	-0.05	-0.04	-0.04	-0.03	-0.02	0.00
2004	% GDP	-0.02	0.00	-0.03	0.01	-0.03	-0.03	-0.02	-0.01	-0.01	0.00
2005	% GDP	-0.01	0.00	-0.02	0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01
2006	% GDP	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.02	0.02
2007	% GDP	0.01	0.04	0.02	0.03	0.03	0.04	0.02	0.03	0.03	0.00
2008	% GDP	0.03	0.01	0.02	0.01	0.04	0.02	0.06	0.03	0.03	0.01
2009	% GDP	0.03	-0.02	0.00	-0.03	0.01	0.01	-0.01	-0.02	-0.06	0.02

Source: Own calculation.

Appendix 5.N. Output gap between actual and potential gross domestic product – developing world *(continued)*

Output gap between actual and potential gross domestic product at constant prices											
	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1980	% GDP	-0.06	0.02	-0.05	0.01	-0.02	0.00	0.06	-0.02	0.01	0.03
1981	% GDP	0.00	0.01	0.02	0.07	0.03	0.03	0.06	0.02	0.03	0.01
1982	% GDP	0.00	0.00	0.06	0.03	0.03	0.06	0.05	0.01	-0.01	-0.01
1983	% GDP	0.07	0.00	0.00	-0.03	-0.07	0.07	0.05	-0.02	0.00	-0.02
1984	% GDP	0.07	-0.02	0.02	-0.03	-0.03	-0.01	0.05	0.02	0.02	-0.01
1985	% GDP	0.04	-0.01	0.06	-0.02	-0.02	-0.09	-0.03	0.00	0.04	-0.02
1986	% GDP	0.05	-0.02	0.08	-0.05	0.10	-0.07	-0.09	-0.01	-0.01	-0.01
1987	% GDP	0.06	-0.01	0.05	-0.04	0.19	-0.04	-0.07	0.00	0.02	0.04
1988	% GDP	-0.05	0.01	-0.11	-0.01	0.08	0.00	-0.04	0.03	-0.02	0.02
1989	% GDP	-0.05	0.00	-0.12	0.01	-0.06	0.04	-0.02	0.04	-0.03	-0.03
1990	% GDP	-0.05	0.00	-0.07	0.00	-0.11	0.05	-0.01	0.03	0.00	0.02
1991	% GDP	-0.05	0.01	-0.02	0.00	-0.09	0.01	-0.02	0.00	-0.01	-0.01
1992	% GDP	-0.05	0.04	0.02	0.00	-0.11	-0.01	-0.03	-0.03	0.03	0.01
1993	% GDP	-0.07	0.01	0.03	0.01	-0.09	-0.02	0.00	-0.03	0.01	0.05
1994	% GDP	-0.04	0.01	0.02	0.02	0.01	-0.01	0.03	-0.02	-0.01	-0.05
1995	% GDP	-0.02	0.02	-0.01	0.05	0.06	0.00	0.03	-0.01	-0.03	-0.02
1996	% GDP	0.01	0.03	0.01	0.03	0.05	0.02	0.04	0.01	-0.01	0.02
1997	% GDP	0.01	0.00	0.03	0.05	0.08	0.03	0.07	0.01	0.00	0.05
1998	% GDP	0.01	-0.01	0.05	0.04	0.04	-0.01	-0.01	-0.01	0.00	0.05
1999	% GDP	0.03	-0.01	0.04	0.01	0.01	-0.02	-0.01	-0.01	0.01	-0.02
2000	% GDP	0.03	-0.01	0.02	-0.04	0.00	0.00	0.03	-0.01	0.01	0.01
2001	% GDP	0.02	-0.03	-0.02	-0.04	-0.04	-0.02	-0.04	-0.01	0.01	-0.08
2002	% GDP	-0.01	-0.04	-0.05	-0.05	-0.04	-0.03	-0.05	-0.01	-0.02	-0.07
2003	% GDP	-0.02	-0.04	-0.07	-0.04	-0.04	-0.02	-0.06	-0.02	-0.02	-0.06
2004	% GDP	0.00	-0.02	-0.06	-0.02	-0.05	-0.01	-0.02	-0.01	-0.01	-0.01
2005	% GDP	0.01	0.01	-0.05	-0.02	-0.03	0.00	-0.01	0.00	-0.01	0.03
2006	% GDP	0.02	0.02	-0.03	-0.01	-0.01	0.00	0.02	0.02	0.00	0.05
2007	% GDP	0.02	0.04	0.03	0.03	0.02	0.03	0.06	0.03	0.01	0.06
2008	% GDP	0.01	0.01	0.06	0.06	0.06	0.02	0.03	0.03	0.02	0.03
2009	% GDP	-0.03	0.00	0.04	-0.01	0.02	-0.01	-0.03	-0.02	0.01	-0.05

Source: Own calculation.

Appendix 5.O. General government consolidated gross debt (b_t) – developed world

	General government consolidated gross debt – debt ratio									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	35.3	74.1	39.1	11.3	20.7	28.2	22.3	69.0	56.9
1981	% GDP	37.0	86.5	51.7	11.7	22.0	31.4	26.5	74.5	58.9
1982	% GDP	39.3	96.1	64.5	14.0	25.3	34.0	29.9	83.7	63.6
1983	% GDP	43.6	106.4	74.2	15.5	26.7	35.6	34.3	93.6	68.4
1984	% GDP	46.1	110.6	77.7	15.4	29.1	36.3	41.0	97.7	74.4
1985	% GDP	48.0	115.2	74.7	16.0	30.6	36.8	47.9	100.6	80.5
1986	% GDP	52.2	120.3	66.5	16.7	31.1	36.8	49.7	111.8	84.5
1987	% GDP	56.0	124.7	62.2	17.9	33.3	38.0	55.9	112.9	88.6
1988	% GDP	57.2	125.1	64.5	16.8	33.2	38.3	61.1	108.6	90.5
1989	% GDP	56.5	122.0	62.0	14.5	34.0	36.9	64.2	99.3	93.1
1990	% GDP	56.1	125.7	62.0	14.1	35.2	38.4	71.0	93.1	94.7
1991	% GDP	56.3	127.1	62.8	22.3	36.0	39.5	73.4	94.5	98.0
1992	% GDP	56.3	128.7	68.0	40.1	39.7	42.1	78.4	91.5	105.2
1993	% GDP	60.9	134.2	80.1	55.3	46.2	45.8	98.3	94.1	115.7
1994	% GDP	64.1	132.2	76.5	57.7	49.4	48.0	96.3	88.6	121.8
1995	% GDP	68.3	130.4	72.6	56.6	55.5	55.6	97.0	82.1	121.5
1996	% GDP	68.3	127.3	69.4	57.0	58.0	58.4	99.4	73.5	120.9
1997	% GDP	64.4	122.7	65.4	53.9	59.3	59.7	96.6	64.3	118.1
1998	% GDP	64.8	117.4	61.4	48.4	59.4	60.3	94.5	53.6	114.9
1999	% GDP	67.2	113.7	58.1	45.7	58.8	60.9	94.0	48.5	113.7
2000	% GDP	66.5	107.9	52.4	43.8	57.3	59.7	103.4	37.8	109.2
2001	% GDP	67.1	106.6	49.6	42.5	56.9	58.8	103.7	35.5	108.8
2002	% GDP	66.5	103.5	49.5	41.5	58.8	60.4	101.7	32.1	105.7
2003	% GDP	65.5	98.5	47.2	44.5	62.9	63.9	97.4	30.9	104.4
2004	% GDP	64.8	94.2	45.1	44.4	64.9	65.8	98.9	29.6	103.8
2005	% GDP	63.9	92.1	37.8	41.7	66.4	68.0	100.3	27.4	105.8
2006	% GDP	62.1	88.1	32.1	39.7	63.7	67.6	106.1	24.8	106.6
2007	% GDP	59.3	84.2	27.3	35.2	63.8	64.9	105.0	25.0	103.6
2008	% GDP	62.5	89.6	34.1	34.1	67.5	66.3	110.3	44.3	106.3
2009	% GDP	67.5	96.2	41.5	43.8	78.1	73.4	126.8	65.5	116.0
2010	% GDP	70.4	98.6	44.9	49.0	83.0	75.7	140.2	97.4	118.9

Source: AMECO database. 'n.a.' stands for 'not available'.

Appendix 5.O. General government consolidated gross debt (b_t) – developed world

(continued)

	General government consolidated gross debt – debt ratio							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	9.9	45.3	n.a.	29.6	16.8	39.4	52.7
1981	% GDP	10.3	49.1	n.a.	37.4	20.6	47.4	52.9
1982	% GDP	10.2	54.5	n.a.	40.9	25.6	56.6	51.7
1983	% GDP	10.8	60.5	n.a.	44.4	31.0	60.2	51.9
1984	% GDP	10.8	64.6	n.a.	48.8	37.1	61.5	53.6
1985	% GDP	10.3	69.7	n.a.	56.5	42.3	61.0	51.8
1986	% GDP	9.9	71.6	n.a.	56.9	43.7	60.5	50.1
1987	% GDP	8.7	74.0	n.a.	54.5	44.0	53.3	47.7
1988	% GDP	6.9	76.6	n.a.	54.1	40.3	47.8	41.4
1989	% GDP	5.7	76.7	n.a.	52.7	41.7	42.8	35.9
1990	% GDP	4.7	76.8	n.a.	53.3	43.6	41.2	33.3
1991	% GDP	4.1	76.6	n.a.	55.7	44.3	49.2	33.6
1992	% GDP	4.8	77.3	n.a.	50.0	46.8	62.2	38.5
1993	% GDP	6.0	78.5	n.a.	54.6	58.4	70.0	44.5
1994	% GDP	5.5	75.7	n.a.	57.3	61.1	72.4	47.7
1995	% GDP	7.4	76.1	n.a.	59.2	63.3	72.2	51.2
1996	% GDP	7.4	74.1	n.a.	58.3	67.4	72.9	51.3
1997	% GDP	7.4	68.2	27.3	54.4	66.1	70.8	49.8
1998	% GDP	7.1	65.7	26.0	50.4	64.1	68.6	46.7
1999	% GDP	6.4	61.1	26.7	49.6	62.3	64.4	43.7
2000	% GDP	6.2	53.8	29.7	48.7	59.3	53.2	41.0
2001	% GDP	6.3	50.7	29.0	51.0	55.5	53.9	37.7
2002	% GDP	6.3	50.5	35.8	53.7	52.5	52.1	37.5
2003	% GDP	6.1	52.0	44.3	55.1	48.7	51.7	39.0
2004	% GDP	6.3	52.4	45.6	56.5	46.2	50.4	40.9
2005	% GDP	6.1	51.8	44.5	61.7	43.0	50.2	42.5
2006	% GDP	6.7	47.4	55.4	63.9	39.6	45.0	43.4
2007	% GDP	6.7	45.3	52.6	62.7	36.1	40.0	44.5
2008	% GDP	13.6	58.2	50.2	65.3	39.8	38.2	52.1
2009	% GDP	14.5	60.8	44.1	76.1	53.2	41.9	68.2
2010	% GDP	18.2	64.8	46.3	82.8	64.4	39.9	77.8

Source: AMECO database. 'n.a.' stands for 'not available'.

Appendix 5.P. General government consolidated gross debt (b_t) - developing world

	General government consolidated gross debt – debt ratio										
	Unit	Algeria	Argentina	Bangladesh	Bolivia	Brazil	Cameroon	Chile	China	Colombia	Costa Rica
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.3	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.2	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.6	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	4.5	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.5	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.9	n.a.	n.a.
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7.4	n.a.	n.a.
1992	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5.0	n.a.	n.a.
1993	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.7	n.a.	n.a.
1994	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.1	n.a.	n.a.
1995	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6.1	n.a.	n.a.
1996	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	15.1	6.8	23.2	n.a.
1997	% GDP	n.a.	34.5	n.a.	n.a.	n.a.	n.a.	13.2	6.6	25.2	n.a.
1998	% GDP	n.a.	37.6	n.a.	n.a.	n.a.	n.a.	12.5	11.4	27.4	n.a.
1999	% GDP	n.a.	43.0	n.a.	n.a.	n.a.	n.a.	13.8	13.8	33.9	n.a.
2000	% GDP	n.a.	45.0	n.a.	66.9	66.7	117.4	13.7	16.4	37.6	39.0
2001	% GDP	n.a.	53.8	n.a.	60.0	70.7	103.8	15.0	17.7	40.6	40.7
2002	% GDP	n.a.	164.4	n.a.	69.3	79.9	74.7	15.7	18.9	47.0	42.9
2003	% GDP	n.a.	139.3	n.a.	74.1	74.8	71.5	13.0	19.2	44.6	42.7
2004	% GDP	n.a.	126.8	n.a.	76.7	70.7	67.9	10.7	18.5	41.2	44.0
2005	% GDP	n.a.	86.8	n.a.	80.4	69.2	64.7	7.3	17.6	38.3	40.4
2006	% GDP	n.a.	76.5	n.a.	55.2	66.7	60.3	5.3	16.5	35.7	36.0
2007	% GDP	n.a.	67.9	n.a.	41.0	65.2	57.8	4.1	19.8	32.5	29.6
2008	% GDP	n.a.	59.6	n.a.	37.5	64.1	53.3	5.2	16.8	32.3	26.0
2009	% GDP	n.a.	59.0	n.a.	40.5	68.9	54.1	6.2	18.6	35.2	28.0

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.P. General government consolidated gross debt (b_t) – developing world *(continued)*

	General government consolidated gross debt – debt ratio									
	Unit	Côte d'Ivoire	Dominican	Ecuador	Egypt	El Salvador	Ghana	Guatemala	Honduras	India
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	43.3	n.a.	n.a.	n.a.
1991	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	44.9	n.a.	n.a.	73.2
1992	% GDP	n.a.	n.a.	n.a.	n.a.	49.3	56.5	n.a.	n.a.	73.6
1993	% GDP	n.a.	n.a.	n.a.	n.a.	38.7	83.1	n.a.	n.a.	74.0
1994	% GDP	n.a.	n.a.	n.a.	n.a.	36.3	124.8	n.a.	n.a.	70.7
1995	% GDP	n.a.	n.a.	n.a.	n.a.	31.4	123.7	n.a.	n.a.	67.4
1996	% GDP	n.a.	n.a.	n.a.	n.a.	31.9	103.8	n.a.	n.a.	64.1
1997	% GDP	121.1	n.a.	n.a.	n.a.	30.5	116.0	n.a.	n.a.	65.3
1998	% GDP	106.6	n.a.	n.a.	n.a.	27.3	105.8	n.a.	n.a.	65.4
1999	% GDP	110.6	n.a.	n.a.	n.a.	28.2	142.2	n.a.	n.a.	67.7
2000	% GDP	109.5	17.0	n.a.	n.a.	29.6	182.2	21.8	72.3	71.4
2001	% GDP	96.8	16.7	65.7	n.a.	33.5	142.0	22.2	69.5	75.8
2002	% GDP	93.6	20.2	54.1	100.9	38.6	133.3	20.0	69.8	80.1
2003	% GDP	90.4	38.0	47.8	114.8	40.3	121.4	22.4	70.8	81.5
2004	% GDP	84.9	24.1	40.5	112.9	40.5	94.1	22.4	61.7	81.7
2005	% GDP	86.3	25.6	35.2	112.8	39.4	77.9	21.5	46.3	79.3
2006	% GDP	84.2	22.7	28.5	98.8	39.4	42.0	21.7	31.7	76.0
2007	% GDP	75.6	20.3	26.7	87.1	38.8	51.9	21.3	19.7	72.9
2008	% GDP	72.5	25.3	21.1	76.6	39.7	59.2	19.9	20.2	72.6
2009	% GDP	65.0	28.4	14.7	76.2	48.5	66.5	23.0	23.7	74.2

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.P. General government consolidated gross debt (b_t) – developing world *(continued)*

	General government consolidated gross debt – debt ratio										
	Unit	Indonesia	Iran	Israel	Jamaica	Jordan	Kenya	Madagascar	Malaysia	Mexico	Morocco
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	n.a.	219.7	n.a.	125.0	79.5	n.a.	89.1
1991	% GDP	n.a.	n.a.	n.a.	n.a.	200.6	n.a.	142.2	72.2	n.a.	74.2
1992	% GDP	n.a.	n.a.	n.a.	n.a.	149.7	n.a.	138.8	63.4	n.a.	86.0
1993	% GDP	n.a.	n.a.	n.a.	n.a.	137.0	n.a.	128.1	54.9	n.a.	95.5
1994	% GDP	n.a.	n.a.	n.a.	n.a.	126.3	n.a.	152.3	46.9	n.a.	88.0
1995	% GDP	n.a.	n.a.	n.a.	n.a.	114.8	n.a.	152.4	41.0	n.a.	92.5
1996	% GDP	n.a.	n.a.	n.a.	n.a.	113.5	n.a.	119.8	35.2	52.0	83.3
1997	% GDP	n.a.	n.a.	n.a.	n.a.	106.9	n.a.	136.7	31.8	47.8	86.2
1998	% GDP	n.a.	n.a.	n.a.	n.a.	109.6	54.1	133.0	36.1	48.6	72.9
1999	% GDP	n.a.	n.a.	n.a.	83.7	108.0	53.1	132.0	36.9	51.6	71.8
2000	% GDP	95.1	20.7	84.4	92.4	100.5	52.1	127.8	35.3	45.5	73.7
2001	% GDP	80.2	18.1	88.8	108.9	96.5	51.2	113.6	41.4	44.3	68.4
2002	% GDP	67.8	25.4	96.6	118.9	99.7	58.6	119.1	43.1	45.9	67.1
2003	% GDP	60.5	26.5	99.0	118.3	99.6	59.7	101.4	45.1	45.6	64.4
2004	% GDP	55.8	26.3	97.4	117.9	91.8	54.3	91.6	45.7	41.4	61.7
2005	% GDP	46.3	23.7	93.5	116.9	84.3	50.1	82.6	44.4	39.8	64.6
2006	% GDP	40.4	19.7	84.4	114.2	73.5	45.4	41.4	43.2	38.3	59.4
2007	% GDP	36.9	17.9	77.6	111.5	71.0	49.1	34.6	42.7	38.2	54.6
2008	% GDP	33.2	21.8	75.4	120.0	58.1	45.6	30.4	42.8	43.3	48.2
2009	% GDP	28.6	21.6	77.6	134.0	61.4	49.2	33.7	55.4	44.9	47.7

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.P. General government consolidated gross debt (b_t) – developing world *(continued)*

	General government consolidated gross debt – debt ratio										
	Unit	Nicaragua	Pakistan	Panama	Paraguay	Peru	Philippines	Singapore	South Africa	Tunisia	Turkey
1980	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1984	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1985	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1986	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1987	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1988	% GDP	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	% GDP	n.a.	n.a.	n.a.	66.9	n.a.	n.a.		n.a.	n.a.	n.a.
1990	% GDP	n.a.	n.a.	n.a.	66.9	n.a.	54.4	71.1	n.a.	n.a.	n.a.
1991	% GDP	n.a.	n.a.	105.7	59.0	n.a.	52.6	74.1	n.a.	66.1	n.a.
1992	% GDP	n.a.	n.a.	93.0	40.7	n.a.	63.0	76.4	n.a.	65.0	n.a.
1993	% GDP	n.a.	n.a.	85.2	30.6	n.a.	74.9	69.0	n.a.	66.5	n.a.
1994	% GDP	n.a.	78.5	79.9	21.2	n.a.	62.4	68.2	n.a.	66.6	n.a.
1995	% GDP	n.a.	73.3	78.2	29.5	n.a.	59.6	68.1	n.a.	68.4	n.a.
1996	% GDP	n.a.	73.4	72.6	27.8	n.a.	51.7	69.6	n.a.	69.4	n.a.
1997	% GDP	n.a.	74.1	67.1	27.9	n.a.	54.3	68.9	n.a.	69.9	n.a.
1998	% GDP	n.a.	76.2	64.8	30.6	n.a.	54.7	82.4	n.a.	61.1	n.a.
1999	% GDP	n.a.	81.0	67.2	39.2	n.a.	57.1	84.9	n.a.	65.0	n.a.
2000	% GDP	n.a.	83.0	66.5	40.7	n.a.	62.1	81.2	42.0	65.9	51.3
2001	% GDP	n.a.	87.9	71.1	50.7	n.a.	62.8	95.4	42.3	67.6	77.6
2002	% GDP	n.a.	81.8	69.4	72.6	n.a.	66.5	95.5	36.0	67.4	73.7
2003	% GDP	n.a.	75.9	64.1	53.1	n.a.	71.4	98.7	36.0	66.4	67.4
2004	% GDP	n.a.	68.3	66.6	45.5	n.a.	69.7	96.0	35.0	53.7	59.2
2005	% GDP	140.5	62.0	62.6	38.0	n.a.	62.8	93.5	33.7	52.5	52.3
2006	% GDP	112.8	56.4	56.0	27.9	33.2	55.4	86.9	31.4	48.8	46.1
2007	% GDP	83.0	54.6	48.5	21.9	30.9	47.8	86.0	27.4	45.9	39.4
2008	% GDP	76.2	58.7	41.2	19.1	25.7	48.7	95.6	26.7	43.3	39.5
2009	% GDP	81.3	57.3	39.9	18.0	27.4	48.9	106.2	30.1	42.8	45.5

Source: Own calculation. 'n.a.' stands for 'not available'.

Appendix 5.Q. Tax burden (τ) – developed world

	Current tax burden: total economy									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	0.412	0.427	0.441	0.380	0.419	0.409	n.a.	n.a.	0.319
1981	% GDP	0.420	0.431	0.438	0.401	0.422	0.405	n.a.	n.a.	0.317
1982	% GDP	0.411	0.444	0.430	0.393	0.433	0.404	n.a.	n.a.	0.342
1983	% GDP	0.407	0.451	0.449	0.390	0.437	0.401	n.a.	n.a.	0.358
1984	% GDP	0.424	0.459	0.458	0.404	0.446	0.403	n.a.	n.a.	0.352
1985	% GDP	0.433	0.460	0.472	0.421	0.444	0.405	n.a.	0.365	0.351
1986	% GDP	0.430	0.457	0.486	0.433	0.436	0.401	n.a.	0.373	0.357
1987	% GDP	0.426	0.463	0.498	0.418	0.440	0.404	n.a.	0.375	0.361
1988	% GDP	0.427	0.449	0.501	0.442	0.433	0.401	0.266	0.385	0.372
1989	% GDP	0.416	0.431	0.488	0.438	0.430	0.403	0.257	0.356	0.378
1990	% GDP	0.419	0.436	0.473	0.450	0.432	0.387	0.279	0.354	0.390
1991	% GDP	0.426	0.439	0.467	0.461	0.433	0.398	0.284	0.361	0.400
1992	% GDP	0.439	0.435	0.471	0.458	0.430	0.405	0.284	0.365	0.407
1993	% GDP	0.446	0.451	0.486	0.451	0.439	0.410	0.291	0.365	0.429
1994	% GDP	0.438	0.454	0.499	0.475	0.443	0.414	0.300	0.374	0.414
1995	% GDP	0.437	0.455	0.498	0.461	0.444	0.412	0.307	0.347	0.413
1996	% GDP	0.452	0.460	0.501	0.474	0.456	0.421	0.311	0.346	0.420
1997	% GDP	0.465	0.466	0.499	0.467	0.457	0.421	0.322	0.338	0.435
1998	% GDP	0.465	0.471	0.502	0.464	0.457	0.423	0.341	0.329	0.425
1999	% GDP	0.461	0.470	0.509	0.460	0.465	0.430	0.352	0.330	0.427
2000	% GDP	0.453	0.467	0.501	0.472	0.457	0.432	0.363	0.326	0.420
2001	% GDP	0.471	0.467	0.493	0.447	0.454	0.413	0.349	0.309	0.417
2002	% GDP	0.457	0.469	0.487	0.446	0.447	0.409	0.354	0.296	0.410
2003	% GDP	0.455	0.463	0.489	0.440	0.444	0.409	0.340	0.301	0.403
2004	% GDP	0.449	0.461	0.499	0.433	0.447	0.400	0.333	0.314	0.403
2005	% GDP	0.440	0.463	0.517	0.438	0.450	0.400	0.339	0.320	0.406
2006	% GDP	0.434	0.458	0.505	0.437	0.454	0.403	0.337	0.334	0.423
2007	% GDP	0.436	0.453	0.497	0.429	0.447	0.405	0.343	0.327	0.433
2008	% GDP	0.442	0.457	0.488	0.429	0.445	0.405	0.340	0.311	0.432
2009	% GDP	0.444	0.450	0.490	0.430	0.434	0.409	0.331	0.294	0.426
2010	% GDP	0.440	0.451	0.462	0.427	0.442	0.397	0.341	0.292	0.426

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.Q. Tax burden (τ) – developed world *(continued)*

	Current tax burden: total economy							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	n.a.	0.438	0.430	0.227	n.a.	n.a.	0.385
1981	% GDP	n.a.	0.432	0.425	0.241	n.a.	n.a.	0.405
1982	% GDP	n.a.	0.440	0.419	0.255	n.a.	n.a.	0.405
1983	% GDP	n.a.	0.447	0.418	0.259	n.a.	n.a.	0.398
1984	% GDP	n.a.	0.432	0.416	0.253	n.a.	n.a.	0.394
1985	% GDP	n.a.	0.433	0.438	0.258	n.a.	n.a.	0.388
1986	% GDP	n.a.	0.438	0.422	0.279	n.a.	n.a.	0.385
1987	% GDP	n.a.	0.459	0.428	0.269	n.a.	n.a.	0.376
1988	% GDP	n.a.	0.458	0.416	0.286	n.a.	n.a.	0.374
1989	% GDP	n.a.	0.430	0.401	0.287	n.a.	n.a.	0.371
1990	% GDP	0.368	0.430	0.404	0.284	n.a.	n.a.	0.370
1991	% GDP	0.353	0.451	0.398	0.297	n.a.	n.a.	0.369
1992	% GDP	0.358	0.445	0.399	0.318	n.a.	n.a.	0.362
1993	% GDP	0.377	0.458	0.396	0.308	n.a.	0.488	0.349
1994	% GDP	0.378	0.434	0.406	0.313	n.a.	0.491	0.353
1995	% GDP	0.381	0.411	0.411	0.317	0.333	0.484	0.361
1996	% GDP	0.385	0.412	0.416	0.325	0.337	0.508	0.356
1997	% GDP	0.403	0.405	0.415	0.324	0.341	0.511	0.360
1998	% GDP	0.403	0.403	0.413	0.328	0.342	0.517	0.371
1999	% GDP	0.390	0.411	0.417	0.333	0.347	0.519	0.374
2000	% GDP	0.399	0.406	0.421	0.336	0.350	0.520	0.379
2001	% GDP	0.404	0.391	0.423	0.334	0.345	0.498	0.377
2002	% GDP	0.400	0.384	0.426	0.342	0.350	0.478	0.362
2003	% GDP	0.389	0.381	0.417	0.347	0.349	0.482	0.360
2004	% GDP	0.381	0.382	0.428	0.339	0.353	0.484	0.364
2005	% GDP	0.383	0.382	0.430	0.350	0.364	0.493	0.374
2006	% GDP	0.366	0.394	0.435	0.357	0.372	0.487	0.381
2007	% GDP	0.364	0.391	0.434	0.360	0.379	0.478	0.376
2008	% GDP	0.360	0.395	0.427	0.357	0.342	0.468	0.375
2009	% GDP	0.379	0.386	0.409	0.339	0.319	0.469	0.364
2010	% GDP	0.377	0.388	0.403	0.351	0.335	0.455	0.372

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.R. Tax burden (τ) – developing world

Country	Current tax burden: total economy (% GDP)
Algeria	0.077
Argentina	0.229
Bangladesh	0.085
Bolivia	0.270
Brazil	0.388
Cameroon	0.182
Chile	0.171
China	0.170
Colombia	0.230
Costa Rica	0.140
Côte d'Ivoire	0.153
Dominican Republic	0.150
Ecuador	0.132
Egypt	0.158
El Salvador	0.133
Ghana	0.208
Guatemala	0.119
Honduras	0.156
India	0.177
Indonesia	0.110
Iran	0.073
Israel	0.368
Jamaica	0.272
Jordan	0.211
Kenya	0.184
Madagascar	0.107
Malaysia	0.155
Mexico	0.097
Morocco	0.223
Nicaragua	0.178
Pakistan	0.102
Panama	0.106
Paraguay	0.120
Peru	0.151
Philippines	0.144
Singapore	0.130
South Africa	0.269
Tunisia	0.149
Turkey	0.325

Source: Heritage Foundation.

Appendix 5.S. Relative position to the fiscal threshold (τ-relative) – developed world

	Relative position to the fiscal threshold									
	Unit	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy
1980	% GDP	0.069	0.084	0.098	0.038	0.076	0.066	n.a.	n.a.	-0.024
1981	% GDP	0.077	0.088	0.096	0.058	0.079	0.062	n.a.	n.a.	-0.026
1982	% GDP	0.068	0.101	0.087	0.050	0.090	0.062	n.a.	n.a.	-0.001
1983	% GDP	0.065	0.109	0.106	0.048	0.095	0.058	n.a.	n.a.	0.015
1984	% GDP	0.082	0.116	0.116	0.062	0.103	0.060	n.a.	n.a.	0.009
1985	% GDP	0.090	0.117	0.129	0.078	0.102	0.062	n.a.	0.022	0.008
1986	% GDP	0.087	0.114	0.144	0.090	0.093	0.058	n.a.	0.030	0.014
1987	% GDP	0.083	0.120	0.155	0.075	0.098	0.062	n.a.	0.032	0.018
1988	% GDP	0.084	0.107	0.159	0.099	0.090	0.058	-0.077	0.043	0.029
1989	% GDP	0.073	0.088	0.145	0.095	0.087	0.060	-0.086	0.013	0.035
1990	% GDP	0.076	0.093	0.130	0.108	0.089	0.044	-0.064	0.011	0.047
1991	% GDP	0.083	0.096	0.124	0.118	0.090	0.055	-0.059	0.018	0.057
1992	% GDP	0.096	0.092	0.129	0.115	0.088	0.062	-0.059	0.022	0.064
1993	% GDP	0.103	0.108	0.143	0.108	0.096	0.067	-0.052	0.022	0.087
1994	% GDP	0.095	0.111	0.156	0.132	0.100	0.071	-0.043	0.031	0.071
1995	% GDP	0.094	0.112	0.155	0.118	0.101	0.069	-0.036	0.005	0.070
1996	% GDP	0.109	0.117	0.159	0.131	0.114	0.079	-0.032	0.003	0.077
1997	% GDP	0.123	0.123	0.156	0.124	0.115	0.078	-0.021	-0.005	0.092
1998	% GDP	0.122	0.128	0.160	0.122	0.114	0.080	-0.002	-0.013	0.082
1999	% GDP	0.119	0.128	0.166	0.118	0.122	0.088	0.009	-0.013	0.085
2000	% GDP	0.110	0.124	0.158	0.129	0.114	0.089	0.020	-0.017	0.078
2001	% GDP	0.128	0.124	0.150	0.104	0.112	0.070	0.006	-0.034	0.075
2002	% GDP	0.114	0.126	0.144	0.103	0.104	0.066	0.012	-0.047	0.067
2003	% GDP	0.112	0.120	0.146	0.097	0.101	0.067	-0.003	-0.042	0.060
2004	% GDP	0.107	0.119	0.156	0.091	0.104	0.057	-0.010	-0.028	0.060
2005	% GDP	0.097	0.120	0.174	0.095	0.107	0.057	-0.004	-0.023	0.063
2006	% GDP	0.091	0.115	0.162	0.094	0.111	0.060	-0.006	-0.008	0.080
2007	% GDP	0.093	0.110	0.154	0.086	0.104	0.062	0.000	-0.015	0.090
2008	% GDP	0.099	0.115	0.145	0.086	0.102	0.063	-0.002	-0.031	0.089
2009	% GDP	0.101	0.107	0.147	0.087	0.091	0.066	-0.012	-0.049	0.084

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.S. Relative position to the fiscal threshold (τ-relative) – developed world *(continued)*

	Relative position to the fiscal threshold							
	Unit	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	United Kingdom
1980	% GDP	n.a.	0.095	0.087	-0.115	n.a.	n.a.	0.042
1981	% GDP	n.a.	0.090	0.082	-0.102	n.a.	n.a.	0.063
1982	% GDP	n.a.	0.098	0.076	-0.088	n.a.	n.a.	0.062
1983	% GDP	n.a.	0.104	0.076	-0.083	n.a.	n.a.	0.055
1984	% GDP	n.a.	0.090	0.073	-0.089	n.a.	n.a.	0.051
1985	% GDP	n.a.	0.091	0.095	-0.085	n.a.	n.a.	0.045
1986	% GDP	n.a.	0.096	0.079	-0.064	n.a.	n.a.	0.042
1987	% GDP	n.a.	0.116	0.085	-0.074	n.a.	n.a.	0.033
1988	% GDP	n.a.	0.115	0.073	-0.057	n.a.	n.a.	0.031
1989	% GDP	n.a.	0.087	0.058	-0.056	n.a.	n.a.	0.028
1990	% GDP	0.026	0.087	0.062	-0.059	n.a.	n.a.	0.027
1991	% GDP	0.010	0.108	0.055	-0.046	n.a.	n.a.	0.027
1992	% GDP	0.015	0.102	0.057	-0.024	n.a.	n.a.	0.020
1993	% GDP	0.035	0.116	0.053	-0.035	n.a.	0.145	0.006
1994	% GDP	0.035	0.091	0.063	-0.030	n.a.	0.148	0.010
1995	% GDP	0.038	0.069	0.068	-0.025	-0.010	0.141	0.018
1996	% GDP	0.042	0.069	0.074	-0.018	-0.006	0.165	0.013
1997	% GDP	0.060	0.063	0.072	-0.018	-0.002	0.169	0.018
1998	% GDP	0.060	0.060	0.070	-0.015	-0.001	0.174	0.028
1999	% GDP	0.048	0.069	0.074	-0.009	0.005	0.176	0.031
2000	% GDP	0.056	0.063	0.078	-0.006	0.007	0.177	0.036
2001	% GDP	0.062	0.048	0.081	-0.009	0.002	0.155	0.034
2002	% GDP	0.057	0.041	0.083	-0.001	0.007	0.135	0.019
2003	% GDP	0.046	0.038	0.075	0.004	0.006	0.139	0.017
2004	% GDP	0.038	0.039	0.085	-0.004	0.010	0.142	0.022
2005	% GDP	0.040	0.039	0.088	0.007	0.021	0.150	0.031
2006	% GDP	0.023	0.052	0.093	0.014	0.030	0.145	0.038
2007	% GDP	0.021	0.049	0.091	0.017	0.036	0.135	0.034
2008	% GDP	0.018	0.052	0.084	0.014	-0.001	0.125	0.032
2009	% GDP	0.036	0.044	0.066	-0.004	-0.024	0.126	0.021

Source: Own calculations. 'n.a.' stands for 'not available'.

Appendix 5.T. Relative position to the fiscal threshold (τ-relative) – developing world

Country	(% GDP)
Algeria	-0.124
Argentina	0.028
Bangladesh	-0.116
Bolivia	0.069
Brazil	0.187
Cameroon	-0.019
Chile	-0.030
China	-0.031
Colombia	0.029
Costa Rica	-0.061
Côte d'Ivoire	-0.048
Dominican Republic	-0.051
Ecuador	-0.069
Egypt	-0.043
El Salvador	-0.068
Ghana	0.007
Guatemala	-0.082
Honduras	-0.045
India	-0.024
Indonesia	-0.091
Iran	-0.128
Israel	0.167
Jamaica	0.071
Jordan	0.010
Kenya	-0.017
Madagascar	-0.094
Malaysia	-0.046
Mexico	-0.104
Morocco	0.022
Nicaragua	-0.023
Pakistan	-0.099
Panama	-0.095
Paraguay	-0.081
Peru	-0.050
Philippines	-0.057
Singapore	-0.071
South Africa	0.068
Tunisia	-0.052
Turkey	0.124

Source: Own calculations.

Appendix 5.U. Data summary – developed world

Country	Years	Success/ failure	Duration (years)	Output gap$_{t-1}$	b_{t-1}	Index fiscal rules (average fiscal epsiode)	Expenditure composition (average fiscal episode)	τ-relative (average fiscal episode)	dCAPB$_t$	RUE$_t$
Belgium	1993-1998	1	6	0.74	128.68	0.78	0.92	0.12	-4.31	0
Belgium	2001	1	1	1.73	107.56	0.43	0.00	0.12	-1.06	0
Denmark	2004-2005	1	2	-1.20	45.81	1.82	0.30	0.16	-2.93	0
Denmark	1996-1999	1	4	0.41	72.46	0.94	1.07	0.16	-2.11	0
Germany	1992-1994	0	3	3.40	39.54	0.99	0.00	0.07	-2.73	0
Germany	1998-2000	0	3	-0.95	59.65	0.99	0.50	0.09	-2.50	0
Ireland	1991-1994	1	4	3.27	93.21	-0.99	0.00	0.02	-2.77	0
Ireland	1996	1	1	-2.34	81.14	-0.99	1.00	0.00	-1.02	0
Ireland	2000	1	1	2.75	48.17	-0.89	1.00	-0.02	-1.23	0
Ireland	2003-2004	1	2	2.96	32.15	-0.56	0.00	-0.03	-2.21	1
Greece	1991-1994	0	4	0.97	71.03	-0.99	0.00	-0.05	-10.48	1
Greece	1996	0	1	-2.99	97.00	-0.99	0.54	-0.03	-1.73	0
Greece	1998	0	1	-2.21	101.81	-0.99	0.00	0.00	-0.78	1
Spain	1996-1997	1	2	-2.45	62.71	-0.17	1.00	0.00	-2.28	0
Spain	1999	1	1	-0.41	63.18	0.12	0.63	0.00	-0.72	0
France	1994	0	1	-2.62	46.24	-0.57	0.97	0.10	-0.83	0
France	1996-1997	0	2	-1.95	55.48	-0.13	0.30	0.11	-2.43	0
Italy	1991-1993	0	3	0.93	94.65	-0.99	0.00	0.07	-5.91	0
Italy	1995-1997	1	3	-2.03	121.84	-0.82	0.32	0.08	-3.82	0
Luxembourg	1993-1995	1	3	2.11	4.79	0.03	1.00	0.04	-4.60	0
Luxembourg	1997	1	1	-4.91	7.78	0.74	0.23	0.06	-1.98	0
Luxembourg	2000-2001	1	2	0.60	6.69	1.45	0.00	0.06	-2.22	0

Source: Own calculations.

Appendix 5.U. Data summary – developed world *(continued)*

Country	Years	Success/ failure	Duration (years)	Output gap $_{t-1}$	b $_{t-1}$	Index fiscal rules (average fiscal epsiode)	Expenditure composition (average fiscal episode)	τ-relative (average fiscal episode)	dCAPB $_t$	RUE $_t$
Netherlands	1991	0	1	1.68	76.85	-0.35	0.09	0.11	-3.19	0
Netherlands	1993	0	1	-0.10	77.35	0.93	0.04	0.12	-2.13	0
Netherlands	1996	1	1	-1.18	76.08	1.57	0.88	0.07	-2.00	0
Netherlands	2004-2005	0	2	-2.18	52.00	1.57	0.96	0.04	-1.90	0
Portugal	1992	0	1	3.54	57.40	-0.99	0.00	-0.01	-2.55	1
Portugal	1995	1	1	-1.95	59.09	-0.99	0.00	-0.01	-2.01	1
Portugal	2002-2003	0	2	2.18	52.95	-0.70	0.00	0.01	-2.70	0
Finland	1996-1998	1	3	-2.60	56.67	0.91	1.00	0.12	-4.91	0
Finland	2000	0	1	1.57	45.53	1.25	0.64	0.13	-4.58	0
Sweden	1994	1	1	-5.84	72.40	-0.28	1.00	0.15	-1.52	0
Sweden	1996-1998	1	3	-2.35	72.09	0.82	0.90	0.17	-7.48	0
Sweden	2000	1	1	0.03	64.79	1.62	1.00	0.18	-1.11	0
Sweden	2004-2005	1	2	-0.72	52.27	1.54	1.00	0.15	-1.45	0
United Kingdom	1994-2000	1	7	-3.00	44.54	1.21	0.77	0.02	-9.48	0

Source: Own calculations.

Appendix 5.V. Data summary – developing world

Country	Years	Success/ failure	Duration (years)	Output gap $_{t-1}$	b $_{t-1}$	Index fiscal rules (average fiscal episode)	Expenditure composition (average fiscal episode)	τ-relative (average fiscal episode)	dCAPB $_t$	RUE $_t$
Argentina	2003-2004	1	2	-0.16	164.44	na	0.40	0.03	10.35	1
Bolivia	2003-2006	1	4	-0.02	69.32	na	0.34	0.07	12.14	1
Cameroon	2005-2006	1	2	0.02	67.95	na	0.17	-0.02	33.79	0
Chile	2006-2007	0	2	0.00	7.28	na	0.23	-0.03	3.13	0
Côte d'Ivoire	2000-2001	1	2	0.08	110.59	na	0.59	-0.05	4.95	0
Ecuador	2006	1	1	0.02	35.22	na	0.03	-0.07	2.69	0
El Salvador	2002	0	1	0.00	33.50	na	1.00	-0.07	2.67	0
El Salvador	1993-1995	1	3	-0.02	49.33	na	0.22	-0.07	16.44	0
Ghana	1998	0	1	0.00	116.02	na	0.18	0.01	2.10	1
Ghana	2009	0	1	0.03	59.25	na	0.96	0.01	5.00	0
Ghana	2000-2003	1	4	0.00	142.25	na	0.25	0.01	9.64	1
Honduras	2004-2005	1	2	-0.03	70.81	na	0.71	-0.05	4.50	0
Jordan	1992	1	1	-0.10	200.63	na	1.00	0.01	8.22	0
Jordan	1999	1	1	0.00	109.59	na	0.68	0.01	3.27	0
Jordan	2003-2004	1	2	-0.03	99.72	na	0.00	0.01	3.09	1
Kenya	2002-2004	0	3	0.00	51.25	na	0.20	-0.02	3.03	0
Madagascar	1999	1	1	0.00	133.02	na	0.68	-0.09	3.23	0
Madagascar	1995-1997	1	3	-0.02	152.33	na	0.35	-0.09	6.12	0
Madagascar	2005-2006	1	2	-0.02	91.61	na	0.50	-0.09	43.45	0
Malaysia	1991-1994	1	4	-0.04	79.54	na	0.66	-0.05	5.26	0
Malaysia	1997-1998	0	5	0.08	35.16	na	1.00	-0.05	1.99	0
Mexico	2000-2004	1	5	0.01	51.57	na	0.47	-0.10	5.10	0

Source: Own calculations.

Appendix 5.V. Data summary – developing world *(continued)*

Country	Years	Success/ failure	Duration (years)	Output gap $_{t-1}$	b $_{t-1}$	Index fiscal rules (average fiscal episode)	Expenditure composition (average fiscal episode)	τ-relative (average fiscal episode)	dCAPB$_t$	RUE$_t$
Morocco	1999	1	1	0.01	72.94	na	0.11	0.02	2.71	1
Morocco	1995-1997	1	3	0.04	87.97	na	0.39	0.02	6.67	1
Morocco	2006-2007	1	2	-0.01	64.55	na	0.42	0.02	5.35	1
Pakistan	1999	0	1	-0.01	76.16	na	0.67	-0.10	2.19	0
Pakistan	2003	1	1	-0.04	81.85	na	0.66	-0.10	3.96	0
Pakistan	2009	1	1	0.01	58.68	na	1.00	-0.10	2.54	0
Panama	1994	1	1	0.03	85.17	na	1.00	-0.10	17.17	0
Panama	2005-2007	1	3	-0.06	66.64	na	0.25	-0.10	6.42	0
Paraguay	1990	1	1	0.01	66.88	na	0.65	-0.08	2.12	0
Paraguay	2001	0	1	-0.04	40.73	na	0.76	-0.08	3.88	0
Paraguay	2003-2004	1	2	-0.05	72.61	na	0.84	-0.08	4.09	0
Philippines	1991-1993	0	3	0.05	54.39	na	0.43	-0.06	3.20	0
Singapore	1997	0	1	0.04	69.56	na	1.00	-0.07	3.00	0.00
Singapore	2007	0	1	0.02	86.92	na	0.20	-0.07	3.87	0.00
Singapore	1992-1994	1	3	-0.02	74.06	na	0.58	-0.07	6.19	0.00
Singapore	2004-2005	0	2	-0.06	98.74	na	0.91	-0.07	2.67	0.00
Turkey	2003-2005	1	3	-0.07	73.67	na	0.81	0.12	10.99	0.00

Source: Own calculations.

Appendix 5.W. Identifying episodes of fiscal consolidation

The same procedure as Zaghini (2001) is adopted to identify relevant fiscal consolidation episodes. This procedure consists of three steps.

1. In the first step it is checked whether the data is properly proxied by the Normal distribution. The mean and variance of the data are first calculated and next the data of the yearly changes of the CAPB is subdivided into 6 groups, as shown in Table 5.W.1.

Table 5.W.1. Sample data distribution- ***step 1***

	Number of observations	
	Developed world	Developing world
$CAPB_i < -2*\sigma$	19	10
$-2*\sigma \leq CAPB_i < -\sigma$	41	25
$-\sigma \leq CAPB_i < 0$	191	323
$0 \leq CAPB_i < \sigma$	178	290
$\sigma \leq CAPB_i < 2*\sigma$	52	18
$CAPB_i \geq 2*\sigma$	11	10

The density of the sample data is then compared to that of a Normal distribution with mean (μ) and standard deviation (σ) equal to the corresponding sample estimates through the following Chi-squared test:

$$\sum_{i=1}^{6} \frac{(n_i - np_i)^2}{np_i} \sim \aleph_6^2$$

where n_i denotes the number of observations in each interval, n is the sample size, i.e. the total number of observations, and p_i is the theoretical probability associated with each interval. The test value for the developed world, 20.70, suggests that the sample data can be considered as drawn from a Normal distribution. In fact, this value is smaller than the 0.1% critical value of a Chi-squared ($\aleph^2$) distribution with 6 degrees of freedom (22.46). The null hypothesis that the Normal distribution is a good proxy of the data is therefore in extremis not rejected.

The test value for the developing world, 166.1, suggests that the sample data cannot be considered as drawn from a Normal distribution. The null hypothesis that the Normal distribution is a good proxy of the data is therefore rejected.

2. In the second step of the procedure the sample is further subdivided as shown in Table 5.W.2.

Table 5.W.2. Sample data distribution - ***step 2***

	Number of observations	
	Developed world	Developing world
$CAPB_i < -2*\sigma$	19	10
$-2*\sigma \leq CAPB_i < -\sigma$	41	25
$-\sigma \leq CAPB_i < -1/2*\sigma$	91	54
$-1/2*\sigma \leq CAPB_i < 0$	100	269
$0 \leq CAPB_i < 1/2*\sigma$	80	51
$1/2*\sigma \leq CAPB_i < \sigma$	98	239
$\sigma \leq CAPB_i < 2*\sigma$	52	18
$CAPB_i \geq 2*\sigma$	11	10

Table 5.W.2. reports the distribution for 8 intervals that are constructed using the values of the mean and the standard deviation of the theoretical distribution for the developed world and the mean and the standard deviation of the sample for the developing world.

3. The two central intervals are assumed as regular. So next, only the observations that are not contained within the two central intervals are assumed to rely on very tight or very

loose fiscal policies. Therefore, the former are considered here relevant fiscal consolidation episodes.

Appendix 5.X. Estimation output Probit model

Developed world

Initial estimation without RUE

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 12/28/10 Time: 03:02
Sample: 1 68
Included observations: 68
Convergence achieved after 3 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
DURATION	-0.105465	0.101001	-1.044199	0.2964
DEBT_RATIO	0.000357	0.004596	0.077714	0.9381
OUTPUT_GAP	-0.100170	0.077108	-1.299087	0.1939
FISCAL_RULES	0.319712	0.175376	1.823004	0.0683
EXPENDITURE_COMPOSITION	-0.316261	0.441546	-0.716258	0.4738

Mean dependent var	0.308824	S.D. dependent var	0.465443
S.E. of regression	0.472703	Akaike info criterion	1.369409
Sum squared resid	14.07724	Schwarz criterion	1.532608
Log likelihood	-41.55989	Hannan-Quinn criter.	1.434073
Avg. log likelihood	-0.611175		

Obs with Dep=0	47	Total obs	68
Obs with Dep=1	21		

Initial estimation with RUE

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 12/28/10 Time: 02:31
Sample: 1 68
Included observations: 68
Convergence achieved after 4 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
DURATION	0.125344	0.162727	0.770270	0.4411
DEBT_RATIO	0.007033	0.005619	1.251523	0.2107
OUTPUT_GAP	-0.109450	0.082407	-1.328157	0.1841
FISCAL_RULES	0.300083	0.184354	1.627756	0.1036
EXPENDITURE_COMPOSITION	-0.769701	0.531534	-1.448075	0.1476
DCAPB	-0.182604	0.126187	-1.447090	0.1479
RUE	-0.821712	0.424127	-1.937421	0.0527

Mean dependent var	0.308824	S.D. dependent var	0.465443
S.E. of regression	0.462941	Akaike info criterion	1.331503
Sum squared resid	13.07315	Schwarz criterion	1.559982
Log likelihood	-38.27111	Hannan-Quinn criter.	1.422034
Avg. log likelihood	-0.562810		

Obs with Dep=0	47	Total obs	68
Obs with Dep=1	21		

Final estimation without RUE

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 12/28/10 Time: 03:04
Sample: 1 68
Included observations: 68
Convergence achieved after 3 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FISCAL_RULES	0.310859	0.162351	1.914734	0.0555
EXPENDITURE_COMPOSITION	-0.553597	0.263265	-2.102817	0.0355

Mean dependent var	0.308824	S.D. dependent var	0.465443
S.E. of regression	0.478305	Akaike info criterion	1.336733
Sum squared resid	15.09921	Schwarz criterion	1.402012
Log likelihood	-43.44891	Hannan-Quinn criter.	1.362598
Avg. log likelihood	-0.638955		

Obs with Dep=0	47	Total obs	68
Obs with Dep=1	21		

Final estimation with RUE

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 12/28/10 Time: 02:40
Sample: 1 68
Included observations: 68
Convergence achieved after 3 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
RUE	-0.781034	0.292471	-2.670469	0.0076

Mean dependent var	0.308824	S.D. dependent var	0.465443
S.E. of regression	0.475725	Akaike info criterion	1.301003
Sum squared resid	15.16304	Schwarz criterion	1.333643
Log likelihood	-43.23411	Hannan-Quinn criter.	1.313936
Avg. log likelihood	-0.635796		

Obs with Dep=0	47	Total obs	68
Obs with Dep=1	21		

Developing world

Initial estimation without RUE

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 01/08/11 Time: 16:10
Sample: 1 39
Included observations: 39
Convergence achieved after 7 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
DURATION	-0.156272	0.271222	-0.576177	0.5645
DEBT_RATIO	0.004110	0.007321	0.561377	0.5745
OUTPUT_GAP	-8.165717	7.718483	-1.057943	0.2901
EXPENDITURE_COMPOSITION	-1.449273	0.762475	-1.900747	0.0573
DCAPB	0.313520	0.216722	1.446645	0.1480

Mean dependent var	0.692308	S.D. dependent var	0.467572
S.E. of regression	0.404868	Akaike info criterion	1.085953
Sum squared resid	5.573222	Schwarz criterion	1.299231
Log likelihood	-16.17609	Hannan-Quinn criter.	1.162475
Avg. log likelihood	-0.414772		

Obs with Dep=0	12	Total obs	39
Obs with Dep=1	27		

Initial estimation with RUE

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 01/08/11 Time: 16:16
Sample: 1 39
Included observations: 39
Convergence achieved after 7 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
DURATION	-0.160248	0.274774	-0.583199	0.5598
DEBT_RATIO	0.004778	0.008173	0.584647	0.5588
OUTPUT_GAP	-8.200880	7.785175	-1.053397	0.2922
EXPENDITURE_COMPOSITION	-1.526605	0.872772	-1.749144	0.0803
DCAPB	0.319731	0.220348	1.451030	0.1468
RUE	-0.159862	0.847063	-0.188725	0.8503

Mean dependent var	0.692308	S.D. dependent var	0.467572
S.E. of regression	0.410021	Akaike info criterion	1.136329
Sum squared resid	5.547863	Schwarz criterion	1.392261
Log likelihood	-16.15841	Hannan-Quinn criter.	1.228155
Avg. log likelihood	-0.414318		

Obs with Dep=0	12	Total obs	39
Obs with Dep=1	27		

Final estimation

Dependent Variable: SUCCESS
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 01/08/11 Time: 16:12
Sample: 1 39
Included observations: 39
Convergence achieved after 6 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
EXPENDITURE_COMPOSITION	-1.326490	0.672849	-1.971454	0.0487
DCAPB	0.305671	0.110587	2.764082	0.0057

Mean dependent var	0.692308	S.D. dependent var	0.467572
S.E. of regression	0.401204	Akaike info criterion	0.988028
Sum squared resid	5.955678	Schwarz criterion	1.073338
Log likelihood	-17.26654	Hannan-Quinn criter.	1.018636
Avg. log likelihood	-0.442732		

Obs with Dep=0	12	Total obs	39
Obs with Dep=1	27		

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